MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

VOL. XLIX. NOVEMBER 9, 1888. No. 1

W. H. M. CHRISTIE, M.A., F.R.S., President, in the Chair.

Thomas Bolton, 8 Carlton Terrace, St. Martin's Square, Scarborough;
Andrew Claude de la Cherois Crommelin, B.A., Trinity College, Cambridge; and
Arthur Herbert Leahy, M.A., Pembroke College, Cambridge,

were balloted for and duly elected Fellows of the Society.

The following candidates were proposed as Fellows of the Society, the name of the proposer from personal knowledge being appended:—

Henry Lord Boulton, Carácas, Venezuela (proposed by Sir H. Grubb);
Ernest William Brown, B.A., Christ's College, Cambridge (proposed by G. H. Darwin);
Samuel Fellows, Tynwald Villas, Lower Villier Street, Wolverhampton (proposed by Joseph Hough);
John James Lewis Goodridge, Bevis Mount, Southampton (proposed by John Newton);
Frederick William Nash, Holmesdale, Birchfield Road, Birmingham (proposed by James Leigh);
Jesse S. Nimkey, The Cottage, Sewardstone, Waltham Abbey, Essex (proposed by Herbert Sadler);
William Schooling, Brechin House, Rivercourt, Hammersmith (proposed by James S. Cooke).

The Numerical Lunar Theory. By Sir G. B. Airy, K.C.B.

(*Extract from a letter to Mr. Knobel.*)

You will remember that some months ago I stated to you that I had discovered an important error in my Lunar theory (the use of one large term only, where I ought to have used two). I have satisfied myself that I cannot remedy this without a greater amount of labour than I am able to give to it at present. From yourself, and from the Royal Astronomical Society, I have received every mark of sympathy with my exertions, and I therefore deem it my duty, at whatever pain to myself, to state to you, and through you to the Royal Astronomical Society and to the scientific world, the failure of my enterprise. It would be useless now to attempt any more detailed explanation of the cause of this failure.

I keep up my attention to the general subject, but with my advanced age (eighty-eight) and failing strength, I can scarcely hope to bring it to a satisfactory conclusion. I will only further remark that I believe the plan of action which I had taken up would, if properly used, have led to a comparatively easy process, and might in that respect be considered as not destitute of all value. . . .

The White House, Greenwich:
1888, *October* 10.

Results of Recent Investigations of Stellar Parallax, made at the University Observatory, Oxford. By the Rev. Professor Pritchard, D.D., F.R.S.

It may be interesting to the Society to be informed respecting the present condition of the work on Stellar Parallax by means of the photographic process, which I have already described in previous communications.

The scheme adopted aims at obtaining in the first instance the "parallax," in the sense in which that term is generally understood, of those stars of the second magnitude which have a suitable declination for observation at Oxford. The parallaxes of those of the first magnitude have already been derived by various astronomers, and very recently have been the subject of investigation by Dr. Elkin with the heliometer.* Such a scheme, if carried out with perseverance and success, cannot fail to contribute in a sensible degree towards our knowledge of what Herschel called the "construction of the heavens."

The results of the application of the method to the two stars constituting 61 *Cygni* have been given in a previous communica-

* Report for the year 1887–8 of the Board of Managers of the Observatory of Yale University.

BIBL. LONDIN. UNIV.

tion. The same process has been more recently applied here to μ *Cassiopeiæ* and *Polaris*. Inasmuch as the process is novel, the whole detail of the work will be published *in extenso*, under the auspices of the Board of Visitors of the Oxford University Observatory. The fasciculus in which these details will be given is very nearly completed for the press.

Besides the parallaxes of these four stars, which in all respects are complete, a provisional determination has been arrived at for α, β, and γ *Cassiopeiæ*. Further, the necessary photographic plates have been secured for completing the investigation of the parallaxes of α *Cephei* and of γ and ϵ *Cygni*. To these should be added α *Coronæ*, α and β *Andromedæ*, making altogether, and including the four stars already mentioned, thirteen stars, the discussion of the parallax of which will be immediately proceeded with, and carried on concurrently with the observation of another batch of second-magnitude stars. I now enumerate these details mainly for the purpose of indicating the capacity of the new method, and the advance already made in its application. If persevered in, it is expected that the parallaxes of about twelve additional stars will be annually added to our present knowledge of this subject, and this I apprehend is the limit of work to be anticipated from the exertions of a single observer, with a single instrument in this climate.

Table showing the Parallaxes of Stars recently determined at the University Observatory, Oxford.

Stars of Comparison.	Magnitude of Comparison Stars.	Differential Parallax.	Probable Error of Result.	Parallax from other Authorities.	
		μ Cassiopeiæ.			
D.M. 54° No. 225	7·7	0″·0211	0″·023	Bessel	−0″·12
„ 54 „ 217	9·2	0·0501	0·027	Struve	+0·342
		Polaris.			
D.M. 88 No. 4	6·7	0·0429	0·015	Lindenau	0·144
„ 88 „ 2	8·3	0·0758	0·014	Struve & Peters	0·172
„ 88 „ 9	8·4	0·0623	0·016	C. A. F. Peters	0·067
„ 88 „ 10	9·6	0·0992	0·013		
		α Cassiopeiæ.			
D.M. 55 No. 142	8·7	0·0748	0·024		
„ 55 „ 128	9·5	0·0678	0·055		
		β Cassiopeiæ.			
D.M. 58 No. 8	8·6	0·1759	0·047		
„ 58 „ 2700	8·8	0·1484	0·056		
		γ Cassiopeiæ.			
D.M. 59 No. 137	8·8	−0·014	0·047		
„ 59 „ 150	8·9	+0·007	0·042		

An examination of the table shows that the Oxford results of some of these stars differ sensibly from those of other observers, who likewise differ greatly *inter se*. Guided by the suggestions of recent experience, I now think that such differences of "parallax" might very reasonably have been anticipated, and may properly be accepted as matters of fact, without in any degree impugning the accuracy of the observations. For in process of this work on parallax, and also from the general history of similar inquiries, it has been made abundantly evident that no necessary connection exists between the brightness of a star and its position in space or distance from the Sun. Nevertheless it is this very difference of brightness mainly which guides us in the selection of comparison stars. The "Parallax" is, in fact, and is becoming more and more generally recognised to be, a differential quantity, fainter stars being in very many instances much nearer to us than others possessing incomparably greater brightness. In passing, I may here instance *α Lyræ* as compared with *61 Cygni*; *β Centauri* as compared with *ε Indi*.* In fact, the position in space of the faint comparison stars in relation to that of the star whose parallax is sought is, if not a matter of accident, at all events wholly unknown until the observations and computations are complete.

The case of *Polaris* in relation to the four comparison stars employed is somewhat remarkable, and I must in candour admit is not apparently in entire accordance with the preceding remark. The differential parallaxes of *Polaris* in relation to these four stars are more or less proportionate to the difference of brightness of *Polaris* and these stars. This difference of parallax so much exceeds the probable error of determination, that I propose to further pursue this somewhat novel and interesting question, by investigating the differential parallax of the comparison stars themselves with the aid of the new photographic refractor, now all but complete, at Oxford.

If these remarks be founded on fact, then any such term as "The mean Parallax" of a group of stars having the same magnitude possesses little or no scientific value, in the sense of its necessarily leading to the slightest knowledge of the parallax of any particular star in that group. In my view of the case, wherever the individual differences are so enormous, there an average of the whole is apt to be misleading and unscientific.

Possibly the researches already made, or being made, by the aid of the spectroscope may in due time lead to some natural classification of stars apart from that of magnitude or brightness. Such a classification, if it can be made, will in no degree detract from the value or dispense with the necessity of parallactic determinations.

Oxford University Observatory:
1888, *November* 8.

* Heliometer-determinations of stellar parallax in the southern hemisphere, by Drs. Gill and Elkin.

On an Instrument for Measuring the Positions and Magnitudes of Stars on Photographs and for Engraving them upon Metal Plates, with Illustrations of the Method of using the Instrument. By Isaac Roberts.

Celestial photography presents for investigation such vast numbers of stars that the necessity of finding new methods for dealing with them is pressed with force upon our attention. How we are to study the characteristics of several millions of stars is a problem pressing for immediate solution. The material for study will soon be abundantly supplied by the various international photo-astronomers when their instruments are erected, but hitherto those who are leading in this new science have apparently not advanced beyond the ideal of dealing with some two millions of the stars when they are photographed, and to them this number seems to be so large that in the lifetime of the existing generation of astronomers they can only hope to be able to leave behind them as a legacy to their successors huge volumes of figures deduced from some thousands of photographic plates.

Those successors, again, must rephotograph the heavens and in like manner produce their huge volumes of figures, and in the second or third generation from this it is anticipated that astronomers may sit down and endeavour to unravel the mysteries which may be lying hidden in the duplex series of figure volumes. This does not appear to be a satisfactory solution of the problem.

The preservation of the negatives so that they would for centuries be available for measurement and study would be a simple solution, but we know that the sensitised films on the plates that must at present be employed will not keep for centuries, and even if some future discovery should produce sensitised films that would be indestructible by lapse of time, or a method of vitrification should succeed, yet the glass plates, which of necessity would have to be frequently handled, could not be ensured against accidental destruction. Metal plates instead of glass might be coated with emulsion, and to ensure permanency each star might with a point be etched through the film and coating of wax upon the metal plates; but this method would be only the result of uncertain hand labour and would also involve the destruction of the photographs, instead of which they ought to be preserved for reference as long as possible. But without enumerating here the many difficulties which are more or less obvious and suggesting methods for the preservation of the glass negatives, we would ask, Are there not other ways of preserving with necessary accuracy the essential parts of the photographs, namely, the star positions and magnitudes? In answer to this question I submit the instrument and method which are the

subjects of this communication, and which have occupied much of my attention during the past three years.

It is well known that copper plates may with ordinary care, and by use of simple means, be preserved for centuries, and if the star images could with accuracy be transferred from the negatives, without causing them injury, on to plates of copper or other metal, and then printed, and when necessary the plates also be duplicated and placed concurrently with the astro-photographic work in the hands of the astronomers of the present day, some of us might be permitted to see a portion of the fruits of our labours instead of leaving all to future generations. With the instrument now to be described the transference of the star images on to copper plates is both practicable and susceptible of great accuracy.

Description of the "Stellar Pantograver."

Plate I. shows the form and some of the details of the instrument.

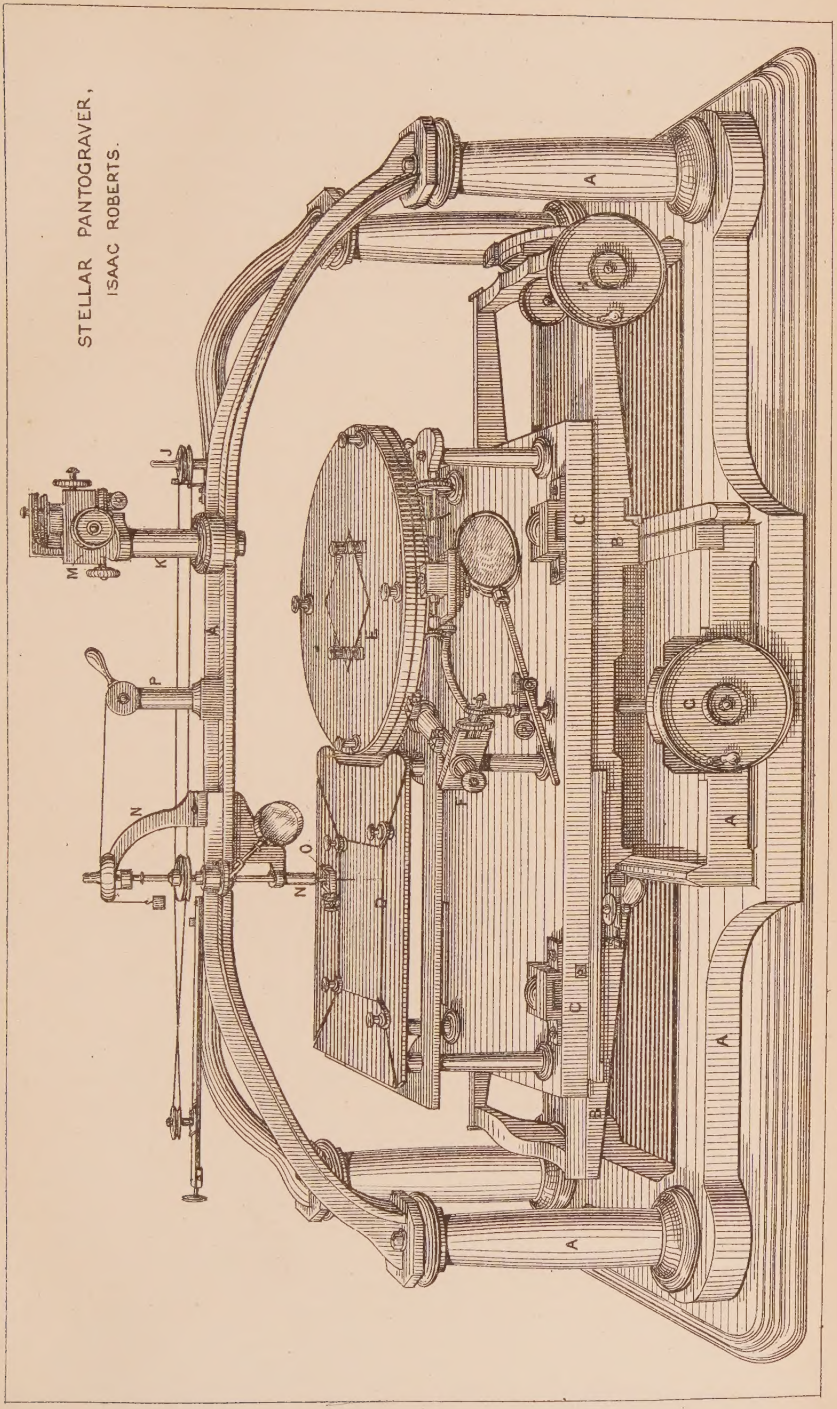
A A A A are parts of the framework. The base plate and bridge on the top are of cast iron. The pillars are of brass.

B is a cast-iron platform, freely movable upon four anti-friction rollers, and guided by a V groove to run in a direction either towards or from the operator.

C is a platform of cast iron and guided in a similar manner to B, but in a direction at right angles to it, or in other words movable in a direction either right or left of the operator. Upon the top of this platform are placed the square stage D and the circular stage E, one to hold and secure the photograph and the other the copper plate to be engraved. The circular stage E is also made to rotate and serve as a large position-circle. It is $13\frac{1}{2}$ inches in diameter, divided on the edge to degrees and five minutes of arc, and with the micrometer and microscope F can be read to seconds and fractions.

The movable platforms B and C have both a slow and quick motion. The slow motion is given by the screws of which G and H are the divided circular heads. The screws are of steel, $\frac{3}{4}$ inch in diameter, and cut 100 threads to the inch. The circular heads are five inches in diameter and divided on the edge to 100 equal parts; the value of one division is therefore 0·0001 of an inch, and by a vernier each division can be read to one-tenth, so that a distance traversed by either stage is measurable to 0·00001 of an inch.

K is a microscope bent at a right angle for convenience, and firmly held in the position shown over the circular stage E. The micrometer eyepiece M has webs which are placed at right angles to each other, and by one movement of the screw each pair of webs may be made to part asunder or to approach each other, as may be required, and form a common centre; thus each photographic star disc is viewed in the microscope with four spider webs

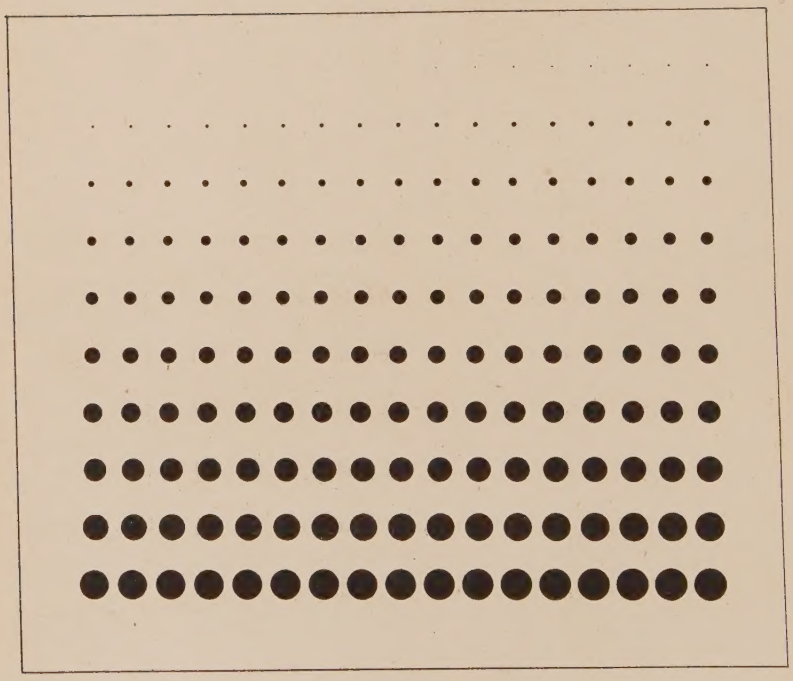

STELLAR PANTOGRAVER,
ISAAC ROBERTS.
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P

Digitized by the Internet Archive
in 2026

https://archive.org/details/monthly-notices-of-the-royal-astronomical-society_1888-11-09_49_1

CIRCLES DRAWN BY ROBERTS'

PANTOGRAVER.



ENGRAVED
FROM A NEGATIVE OF THE
PLEIADES
by PROF. PRITCHARD.

placed tangentially against its margin, and the common centre of the webs is the centre of the star disc. The diameter of the star disc is measured to 0·0001 of an inch upon the heads of the screws of the micrometers. Two measurements at right angles are taken simultaneously, thus checking each other and at the same time showing if the star disc is round, together with the extent of deviation, if any, from the circular.

N is the engraving tool. It consists of a vertical steel shaft in gun-metal bearings. On the lower end of the shaft is fixed a micrometer, with screw cut 100 threads to the inch and head divided into 100 equal parts. The measurements are therefore made to 0·0001 of an inch, like those of the eyepiece micrometer. On the under side of the micrometer O is a steel pin carrying a fine diamond point, which is the graver, and it is fixed to a sliding piece attached to the micrometer screw, by the turning of which it is moved eccentrically to the extent required to trace a circle which is either equal to or is any proportion required of the star diameter on the negative. The readings of this micrometer are double those of the eyepiece micrometer, and by inspection and rotation of the heads of both these micrometers circles of any diameter from a point up to 0·16 of an inch can be traced with the diamond point of the graver.

P is a lever to lift the graver off the plate.

J is the wheel for rotating the graver.

Plate II. shows 160 circles which were traced upon copper, and afterwards transferred to lithographic stone and printed. The largest of the circles measures 0·16 of an inch in diameter, and each successive circle is 0·001 of an inch smaller in diameter than the one preceding it. The last is a point. The instrument is graduated so that circles can be drawn which will be either smaller or larger in diameter than each other within the limits of measurement.

From the foregoing statements it is apparent that a degree of accuracy in drawing stellar positions and magnitudes from the negative should practically be equal to the original negative, and, in order to demonstrate the closeness of theory with practice in this matter, I applied to Professor Pritchard for the loan of one of his negatives of the *Pleiades*, so that I might engrave the stars on copper plate, and he obligingly sent one that had been exposed for the same time as those used in the general determination of parallax; moreover he measured the engraved stars, as well as those which have been printed from the copper plate upon paper and shown in Plate III.

The following table gives the results of his measurements:—

Results of Measurement of Star Distances on the Copper Plate of Pleiades compared with those of the Original Negative.

Names of Stars Measured (Bessel's Notation).	Distance on Negative in Inches.	Distance on Copper Plate in Inches.	Difference in Inches.	Difference in Arc.	
	in.	in.	in.	″	
From Maia to No. 4	0·11703	0·11609	0·00094	1·63	
„ „ Celeno	0·51980	0·51876	0·00104	1·80	
„ „ Electra	0·70567	0·70528	0·00039	0·67	
„ „ Wolf, No. 47	0·85096	0·85064	0·00032	0·55	
„ „ No. 1	0·72708	0·72788	0·00080	1·38	
„ „ Merope	0·91772	0·91711	0·00061	1·06	
„ „ No. 10	0·38450	0·38536	0·00086	1·49	
„ „ ρ	0·90537	0·90600	0·00063	1·09	
„ „ η	0·97170	0·97119	0·00051	0·88	
„ „ No. 21	0·98982	0·99016	0·00034	0·59	
„ „ Asterope	0·35427	0·35471	0·00044	0·76	
„ „ No. 5	0·55281	0·55235	0·00046	0·80	Mean 1″·06

Average Deviation of Bisections of Star Discs on Copper Plate.

0·00009 in. or 0″·16.

Average Deviation of Bisections of Star Discs on Negative.

0·00007 in. or 0″·12.

Comparison of Measures on Paper Print with Original Negative.

Names of Stars Measured (Bessel's Notation).	Distance on Negative in Inches.	Distance on Copper Plate in Inches.	Difference in Inches.	Difference in Arc.	
	in.	in.	in.	″	
From Maia to No. 4	0·11703	0·11688	0·00015	0·26	
„ „ Celeno	0·51980	0·51911	0·00069	1·19	
„ „ Electra	0·70567	0·70760	0·00193	3·34	
„ „ Wolf, No. 47	0·85096	0·85084	0·00012	0·21	
„ „ No. 1	0·72708	0·72966	0·00258	4·46	
„ „ No. 21	0·98982	0·99084	0·00102	1·76	Mean 1″·87

Five bisections were taken for each distance, and the mean of the five was taken.

The average discrepancy between the measures taken on the copper plate and on the negative is 1″·06.

Between the paper and the negative the average discrepancy is 1″·87.

It is found that the error (average) of bisection of a star on the original negative, compared with that on the copper plate, is as 3 : 4.

The paper print was somewhat creased and probably hygroscopic. Prof. Pritchard adds, 'I regard this first attempt as eminently successful.'

It is desirable in the engraving of stars upon copper plates, with the view of printing them, that the photographic diameters should be increased at least twofold, or some other definite proportion, for if they are drawn only to the sizes on the negatives the faint stars are very small points which are difficult to see and measure. This can be done by the instrument.

I find a magnifying power of 24 with a field of two-tenths of an inch in diameter a very convenient one for viewing the stars on the negatives for engraving.

The instrument is adapted for cutting out the interiors of the star discs after their outlines are traced on copper plates, but it is a better plan to transfer the outlines on to lithographic stone and then fill in the interiors with a pen or brush. This saves both time and cost, and, what is of still greater importance, saves the plates themselves from injury by frequent pressure and wear. Many thousands of printed copies could thus be produced from one impression taken from the copper plate.

I find by experience that I can easily engrave 50 stars in an hour. If, therefore, an engraver worked during 8 hours a day for 48 weeks in the year, he would with one instrument transfer to copper plates 115,200 stars. If 20 instruments were thus employed during 10 years, 23,040,000 stars would be permanently placed on record, so that the astronomers of the present time could do great work, and afterwards leave their data unimpaired to the scrutiny of succeeding generations of astronomers in a form available for centuries to follow. Thus we should make a valuable contribution towards the solution of the great problems: Whence came our speck of Earth? Whither is it going?

The pantograver was made under my directions by Mr. Hilger, and I highly appreciate his skill in overcoming difficulties, and also the perfection of his workmanship, without which (or their equal) the success of the method would not have been attained.

Illustrations of the Method of using the Stellar Pantograver.

The machine is constructed of a size that plates which do not exceed eleven inches square can be engraved by it, and stars or other objects can be traced by an ordinary mechanic or other person to practically the accuracy of those on the plate or negative.

In using the machine a plate of glass the size of the negative to be engraved is ruled with parallel faint lines one-tenth of an inch apart, and in the case of a plate 4 inches square each line is numbered at the ends in consecutive order from 1 to 40. The plate is placed upon the stage under the observing microscope,

with the ruled side uppermost. The negative is then placed and secured upon the glass plate with the film side down, and in contact with the ruled lines. This arrangement will ensure the stars when they are engraved upon the copper plates, and afterwards printed on paper, being in the same order of right ascension and declination as those on Argelander's chart. This, I submit, is desirable, because that chart will form a valuable key to the photographic chart, and is immediately available for the study of stellar changes.

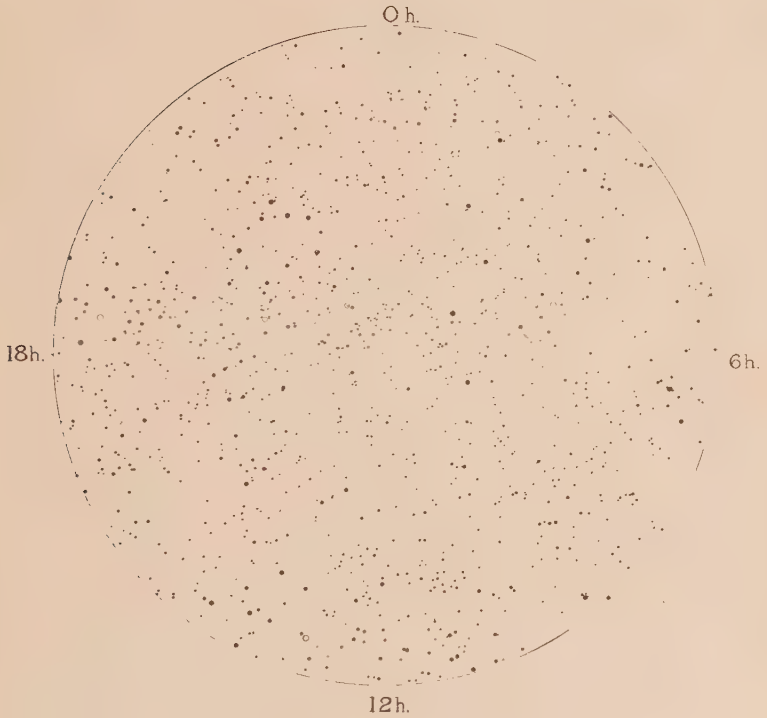
The copper plate is next placed on the stage under the engraving point, and its position adjusted and fixed as required. As already stated the magnifying power I use in engraving is 24 diameters, and this gives a clear field of two-tenths of an inch in breadth. All the stars within the space enclosed by the lines are brought successively and accurately to the optical centre of the microscope between the four adjustable threads of the eyepiece micrometer, and the diameter or magnitude of each star is read off on the screw-head to 0·0001 of an inch. The same reading is then given to the screw-head of the engraving point micrometer. The point is then lowered to impinge upon the copper plate, and the tool handle twice rotated to cut the ring which represents the position and diameter of the star on the negative. In this way each star on the negative can be engraved both accurately and expeditiously, and without unduly taxing the attention of the operator, at the rate of 50 to 60 stars an hour. If any uncertainty should at any time arise as to whether any star has or has not been engraved, the resetting of the instrument will at once determine it, and specks or other defects in the film can with certainty be detected and eliminated.

The accuracy of the work done by the machine has been tested in various ways besides those already referred to, but the following example will suffice. Four stars at distances apart of 0·35 inch and 0·46 inch on a negative were selected and brought successively under the microscope and then engraved on a copper plate, first as a point in the centre of each ; then a series of concentric circles were drawn round the central point, the instrument being moved freely by hand in any direction between each operation of drawing the central point and circles. At the completion of the operations the circles were practically concentric with the central point and with each other.

Plate IV. is a chart of 1,270 stars within a circle of one degree of the North Pole as the centre, and it was engraved from a negative taken on the 14th of August this year, with an exposure of 105 minutes. The diameter of the circle is two degrees. Carrington and Argelander on their charts show 38 stars on this area, and they are distinguished on Plate IV., as nearly as I could recognise them (for they do not all coincide), by the white circles with a black spot in the centre.

This chart of the Polar circle will serve as an illustration of

CHART OF NORTH POLAR STARS
BY
ISAAC ROBERTS.



ENGRAVED FROM A PHOTOGRAPH TAKEN ON 14TH AUGUST 1888. THE WHITE STARS REPRESENT THOSE ON ARGELANDER'S CHART. CIRCLE 2° DIAMETER.

the importance to working astronomers of this method of engraving, printing, and circulating without delay the work of the photo-astronomers, both international and private, for it places in their hands a strongly marked index showing them at a glance the exact spots in the sky, where perceptible changes in the positions and magnitudes of the stars have taken place since the dates of the several published charts.

The fact being established by inspection, measurements, or eye alignments that changes according to the charts have taken place among the stars, there is obvious necessity for measuring the negative or copper plate and use of the transit instrument, and in a few months' time after publication of the photographic chart there will be ample work for all the astronomers in the world to determine whether those differences are due to actual changes in the objects or to errors in the charting, and then will follow computations and evolution of laws which will occupy their lifetime and those of succeeding generations of astronomers.

These suggestions for immediately utilising the existing charts by comparison with the photographic chart, would suggest that modifications should be made in the international scheme for the formation of a catalogue of some two million stars, and, instead of the proposed 15 minutes' exposure of the plates, at least an exposure of 60 minutes to a clear sky ought to be substituted, and the stars charted to the faintest magnitude such an exposure would imprint even as a stain on the films. By these modifications of the scheme, a chart of the sky worthy of the resources of the present day would immediately be commenced, and within the next ten years accurately printed copies showing all stars down to the 16th or 18th magnitude would be in the hands of all persons interested in astronomical investigations.

I have now shown, and I think demonstrated, the practicability of the scheme for engraving. The question of the form in which the printed charts should be issued could be answered in at least two commendable ways: *first*, with four photo-squares on each leaf in a book of strong paper; *second*, as separate photo-squares on octavo sheets of strong paper, and numbered in consecutive order and with an index, the sheets being kept loose in book boxes containing 500 each, so as to be available for micrometric measurements. This I think would be the most convenient method, as will be seen if we proceed to consider the way that astronomers would be likely to adapt for themselves their future work, which we will assume to be somewhat in the following order, namely:—

Astronomer A is desirous of investigating the stars within the radius of one degree of the Pole as a centre, and is possessed of the printed charts and an instrument of precision for measuring. He knows in which country the photo-astronomical work of this region is done, and he also knows the bureau where the negatives and engraved plates are kept. The bureau ought to be in

a building forming part of or contiguous to the national observatory of each country, and under the control of the national astronomer. Our typical astronomer, having studied the printed chart and therein found matter requiring closer investigation, requests the head of the bureau to send him a copper-plate duplicate of the original, of the sky space indicated, and with his request remits the standard fee. In due course he receives what is practically the original negative (the copy being exact), and then resumes his investigations, and within a brief interval of time he is in a position to inform the astronomical world that he has found something new to tell.

The method hitherto followed in designating stellar magnitudes by numerals and decimal parts will not be the most desirable in the new photo-astronomy, as will be evident on examination of the microscopic gradations of the engraved circles representing the star discs. The determination of magnitude should no longer be empirical, but be the result of exact measurement by micrometer, and in place of assuming a given number of magnitudes such as 1st or 18th, there may be one hundred or more measurable magnitudes between the brightest star and the faintest on any negative or copper-plate copy, or printed chart. The future designation may be in parts of an inch or of a millimetre.

In the pantograver the eyepiece and engraving micrometers are divided to measure 0·0001 of an inch, and if the star discs on the negatives were both circular and sharply defined on the edge, estimated measurements to 0·00002 of an inch could be made and registered as the stellar magnitude; but in practice these conditions seldom occur, and the edge of the disc is undefined, by reason, probably, of atmospheric tremor and glare; hence measurements of magnitude will be $\pm$ 0·001 of an inch, and the gradations would therefore be somewhere within this limit. If the disc of the brightest star, say *Sirius*, were represented on the photograph by 0·08 of an inch, and the faintest star by 0·002 of an inch, there would by the gradation here suggested be seventy-eight measurable stellar magnitudes, each one of which would be distinctly recognisable by measurement.

The pantograver is also an instrument of precision for measuring stellar distances and position-angles. Any distance not exceeding 11 inches can be measured theoretically to 0·00001 of an inch in two directions at right angles to each other, and in my photo-telescope, which is 98 inches focal length, one second of arc is equal to 0·00476 of an inch, being a large measurable quantity.

There are many details connected with the subject-matter of this paper that I must defer for future discussion.

Chart of 1,270 *North Polar Stars.*

The following are the positions and magnitudes of the 38 stars on Argelander's chart, which are shown as *white circles* on the accompanying engraved photo-chart (Plate IV.).

Magnitude.	Right Ascension.	Declination.	Magnitude.	Right Ascension.	Declination.
	h m s	° ′ ″		h m s	° ′ ″
9·5	0 11 5	89 36 2	9·5	12 0 23	89 26 3
9·2	1 17 35	0 2	8·8	12 59 20	28 3
8·8	1 49 36	29 2	8·7	13 3 53	8 7
9·4	1 50 57	23 6	9·4	13 25 6	32 6
9·5	1 51 58	13 3	9·5	15 3 47	24 2
9·4	2 16 43	0 6	9·0	15 14 45	40 9
9·3	3 11 12	4 3	9·5	15 44 3	55 1
9·5	3 53 49	0 5	9·5	15 45 16	2 8
9·1	4 49 39	27 1	8·7	17 21 38	18 4
9·5	5 43 44	6 0	9·4	18 7 27	43 8
9·5	5 57 3	3 6	9·3	18 42 30	9 5
9·1	6 17 38	37 9	9·5	19 29 17	38 0
7·0	7 3 40	1 8	9·5	19 37 46	12 9
9·5	7 14 2	1 0	9·5	19 45 0	27 5
9·2	7 27 50	1 6	9·3	19 56 5	14 3
9·5	8 58 47	39 4	9·3	20 13 29	45 9
9·0	10 26 21	32 0	9·5	21 8 21	31 7
8·9	11 8 27	43 9	9·3	22 6 40	48 0
9·5	11 9 11	32 9	9·0	23 21 18	0 8

On a Compensating Pendulum. By Richard Inwards.

The pendulum about to be described must not be taken as novel in all its parts. So much has been done that such entire novelty would now be impossible. But what I hope is that the general arrangement with its many new features may result in a substantial improvement on existing forms.

In accurate pendulums in which the temperature compensation is obtained by the expansion in contrary directions of tubes of zinc and steel, there has always been a great difficulty in at once apportioning the respective lengths of the rods or tubes used for the purpose.

This difficulty arises in a great measure from the fact that no two specimens of the metals can be readily obtained having exactly the same coefficient of expansion. Particularly with the zinc is

this the case, as one may see by consulting the different horological and mechanical text-books, where widely different figures are given as based on the experiments of various investigators.

Even in the best clocks, where the proportions of the tube-lengths have been most carefully adjusted by theory, it is often found necessary to dismount the pendulum in order to alter the length of the zinc tube.

In the Westminster clock this has, I believe, been done on at least two occasions, when pieces of zinc had to be inserted in order to bring the compensation to its present apparently perfect condition.

The zinc tube in the usual pendulum is under powerful compression in having to sustain as a pillar the whole weight of the bob, and it may be that it requires some time before its atoms settle down to a steady rate of expansion under this heavy strain. It may also be that the tube shortens a little by bending in the middle. In any case, the remedy involves stopping the clock and making up the pendulum again.

Many contrivances have been suggested for the purpose of meeting this difficulty, but all involve some disadvantages. That of Ellicott has a number of pivots and joints to be adjusted, while the plan proposed by our own esteemed Fellow, Mr. Buckney, has the disadvantage of carrying a considerable piece of surplus zinc, and of the necessity of entirely retiming the clock after the alteration. A plan proposed on somewhat similar lines by myself* is open to the same objections.

By the method now proposed the alteration in the proportionate lengths of the zinc and steel can be made at once while the clock is going, and if erroneously altered can be corrected at any time, also without stopping the clock.

This is to be done by transferring the compensating rods or tubes to the fixed part of the clock.

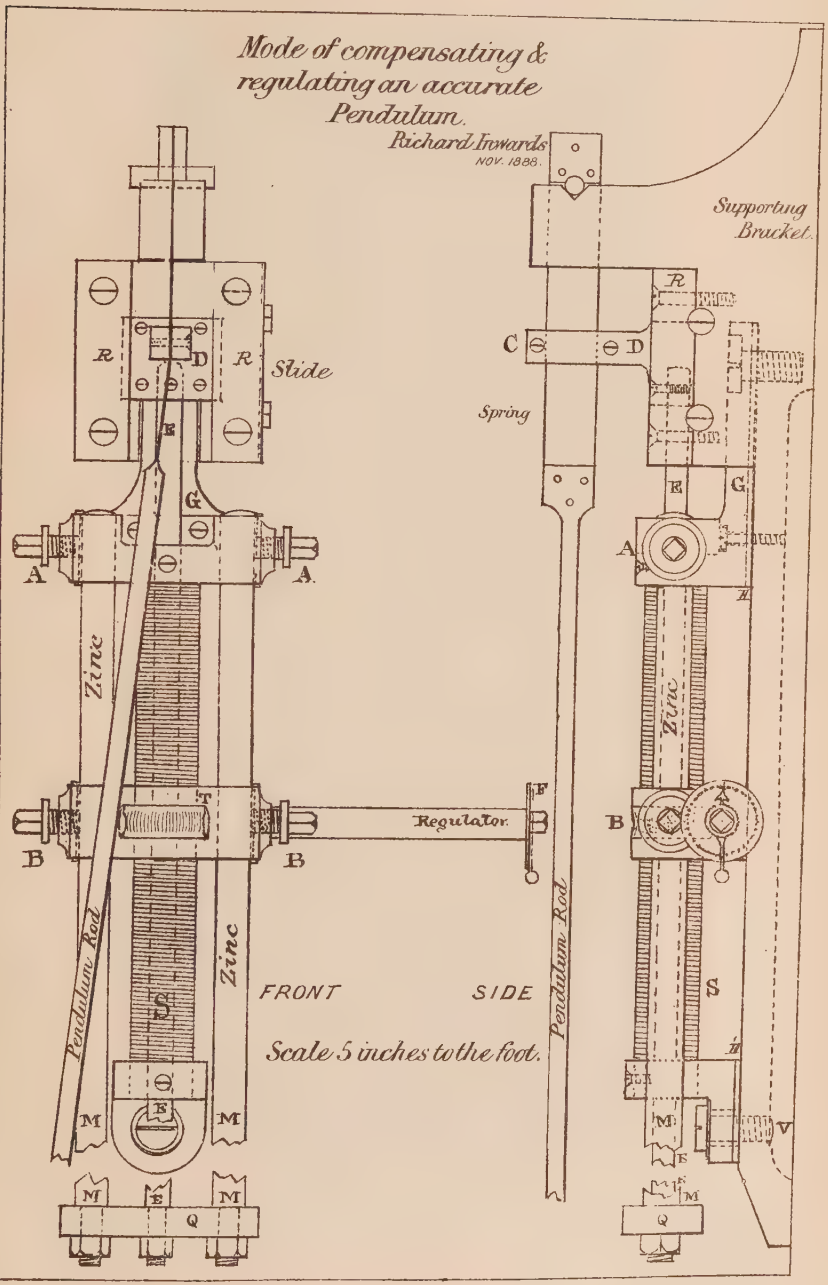
In the accompanying drawings the means of carrying out the proposed changes are depicted.

The woodcut in black shows the general arrangement of the pendulum, while the whole-page plate gives elnarged front and side views of the upper portion. The letters refer to the same parts in each diagram.

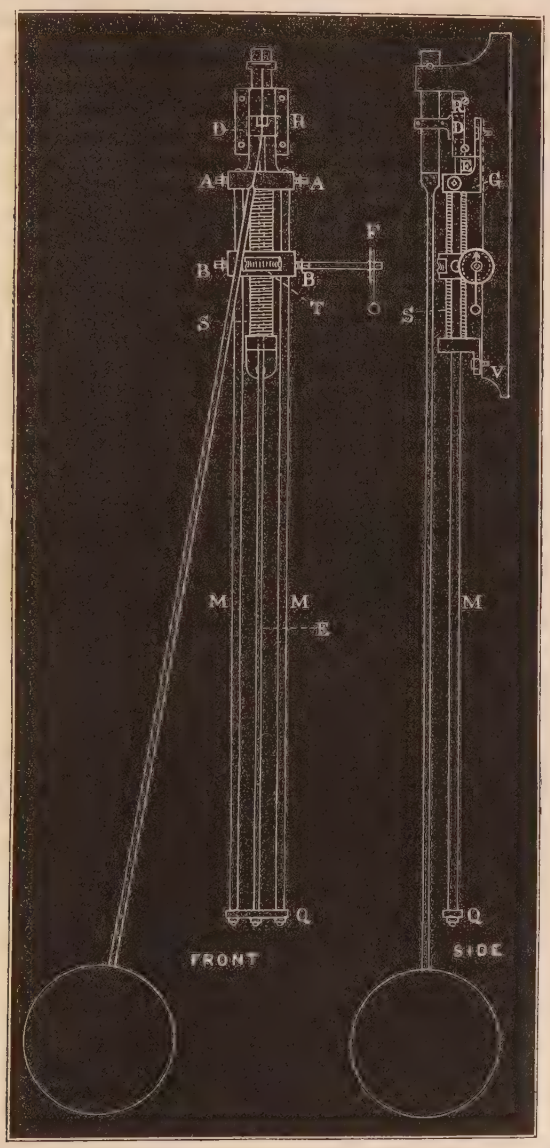
It will be seen that the pendulum is supported in the usual way from a strong cast iron projection, and is suspended by a spring of somewhat greater length than is customary.

About the middle of the spring it is grasped by a clip consisting of two arms D, which are adjusted to embrace it with sufficient closeness to hold it firmly, but loose enough to allow of movement in a vertical direction. There are screws to regulate this pressure, and I should propose to add a lining of wood or leather to the clips where they bear upon the pendulum spring. The arm D is fixed to a block which moves vertically between two slides, very similar to a smaller copy of those on a lathe slide

* *Horological Journal*, September 1886.


Mode of compensating & regulating an accurate Pendulum.
Richard Inwards
NOV. 1888.
Supporting Bracket.
Slide
Spring
Regulator.
Zinc
Zinc
Zinc
Pendulum Rod
Pendulum Rod
FRONT
SIDE
Scale 5 inches to the foot.

rest. The slide has setting screws, and ought to admit of no horizontal motion whatever. It may be remarked in passing



that there is a great distinction in steadiness between this plan and that which has been often proposed, and in which the whole

pendulum support is moved so as to pull up the spring between the fixed chops, and in which case the weight of the pendulum is carried by a movable support instead of a fixed one.

In the present plan, by the further addition to the clips of a spring stiffer than the pendulum spring, and with a similar one on the side of the sliding block D, all possibility of the smallest lateral tremor would be cut off. Another advantage of these additional springs would be that the clips would slightly yield, and so override any small impediment such as dust or a spot of rust either on the pendulum spring or on the fixed part of the slide.

The sliding block D is attached to the end of a steel rod E of small diameter (as it has scarcely any strain to bear), and of about 30 inches long, and which passes down at the back of the pendulum-rod to a point a little above the level of the bob. Here it is fixed to the middle of a bar Q, which at its ends is made fast to the two zinc rods or compensating bars MM. These are about 29 inches in length, of which about 26 inches are acting on the pendulum. The zinc rods are firmly fixed at B to a block carrying in its centre a worm-wheel of 60 notches, T.

This worm-wheel, which is a kind of nut, turns on a fixed screw S (of 18 threads to the inch), firmly attached to the supporting bracket, and prevented from turning round.

The tangent screw actuating the wheel or nut T is behind it (not seen in the drawing). The axis of the tangent screw is prolonged to F, where it carries a dial of 32 divisions, and forms the regulating apparatus by which the timing of the clock is done, as well as making such alterations in the proportions of the lengths of zinc and steel as may be found necessary.

It will be seen that if the wheel T is turned it must rise or fall on the fixed screw S, and so through the medium of the zinc and steel rods raise or depress the sliding block moving on the pendulum spring above, and so altering the length of the pendulum. This is the proposed timing adjustment, and it will be found that one division of the regulating dial F will correspond to an alteration in rate of about one second per month. This is sufficiently delicate to obviate the necessity of adding small weights to the pendulum. The adjustment is made while the clock is going, and can also be used as a means for temporarily accelerating or retarding the clock.

A mechanical friend of great experience says that in altering this dial, say, to the right one division, it should first be turned a quarter of a turn to the left, and then brought one degree forward from where it stood before. This eliminates an error which might arise from slip or from hesitancy in moving.

Now to alter the proportion of zinc in the pendulum nothing more is necessary than to *first* tighten the binding screws AA (which must always be loose at other times), and then to slacken the screws BB. The effect of this is to release the regulator

from all connection with the pendulum, and make the zinc rods practically a part of the fixed bracket or support. Then by turning the regulating dial the effect will be that the worm-wheel T simply travels up or down the fixed screw, and changes the position of the binding screws B (now loose) with respect to the zinc rods. When this position has been altered so as to add or take away sufficient of the length, the screws B must be tightened while A A must be loosened (or perhaps better taken away till wanted).

It will be seen on carefully studying this plan that the upper part of the steel rod E is balanced as regards expansion by the expansion in a contrary direction of the support G and that of the part of the screw S above the tangent wheel.

G must therefore be of steel, so must S, and it is well that they should be of uniform thickness, say a quarter of an inch, so as to take up heat at equal rates.

The piece G is separated from the planed bed of the bracket by slips of bone (H, H′ on plate), with the object of allowing it to behave independently of the heavier cast-iron bracket, as regards expansion. Of course the lower screw V must pass through an oval hole, and may be kept up to a working contact by placing what is known as a spring washer or bent disc of steel underneath the head of the screw.

If these suggestions are, as I hope, practical, a great many minute sources of error in the pendulum will be got rid of by this form of construction. The pendulum itself will be brought almost to its ideal form, a mere ball of lead supported by a thin stem or wire. The resistance of the air to the pendulum rod will be reduced to a minimum. The proper proportion of zinc to steel can be at once restored, even after the minute displacement which occurs in timing. No useless weight will be carried. The clock need never be stopped except for cleaning or removing, and its rate and compensation can be altered even to the most minute degree while it is going.

The zinc used should be subjected to boiling and freezing before being attached to the pendulum, especially if in the form of drawn rods or tubes.

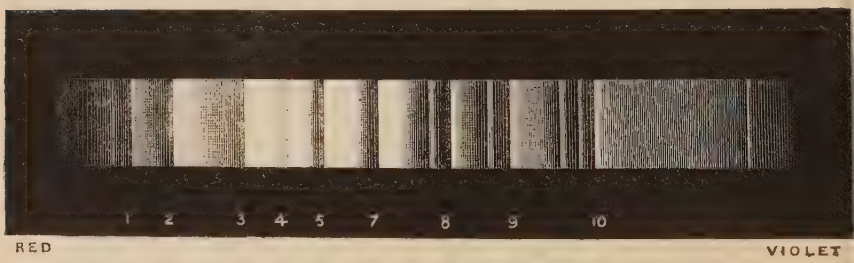
All these seem small matters, but it is with the "next to nothings" that we have now to deal, in striving to add the last perfections to our already nearly perfect timekeepers.

20 *Bartholomew Villas, N.W.:*
1888, *November* 8.

On the Spectra of R Cygni and Mira Ceti and some Stars with probably similar Spectra. By Rev. T. E. Espin.

R Cygni.—On August 13 a very bright line, apparently F, was visible in the spectrum of this star. The line was subsequently seen on several nights, and was measured and confirmed by Dr. Copeland at Dun Echt.

Mira Ceti.—During the maximum of this star the colour was very pale yellow; as soon as the maximum was passed the colour gradually inclined to orange. The accompanying drawing gives the appearance of the spectrum on October 23 in strong moonlight, and on October 30 on a dark sky, when the star had faded considerably. The observation of October 30 only added one new detail to the spectrum; this was the fact that band No. 8 in Dr. Dunér's nomenclature was really divided into two. Band No. 9 is also broken up into at least two, and band No. 10 into three. Whether these interferences in the bands are due to bright lines I am unable definitely to say.



Spectrum of *Mira Ceti*, 1888, October 23, 30.

The numbers refer to Dr. Dunér's bands.

Further away in the violet there is a brilliant line which may be the γ hydrogen line. The beauty of the spectrum is beyond anything I have seen. The spectrum was observed with a direct-vision prism before an eyepiece magnifying 200 times. By altering the distance between the prism and the eyepiece increased length of spectrum is obtained at pleasure. With the prism close to the eyepiece the spectrum of α *Orionis* consists of the usual III. type bands; by moving the prism six inches or so away from the eyepiece the bands are resolved into innumerable lines.

Since Professor Pickering discovered the bright lines in *Mira Ceti* and in Mr. Gore's star in *Orion*, I have examined very many

of the known III. type stars, but only in the case of the following have I been led to suspect a spectrum with bright lines. If the bright lines really exist in these stars they are very difficult objects. The full aperture of the $17\frac{1}{4}$ reflector is not sufficient really to deal with them satisfactorily.

		1855.		
(1) Südl. D.M. $-12°\cdot1092$	$\alpha=$ V. 4 36·9	$\delta-12°$ 1·8	Mag. 6·5
(2) D.M. $+39°\cdot3476$	XVIII. 33 19·2	$+39°$ 32·8	„ 6·5
(3) D.M. $+49°\cdot2999$	XIX. 20 44·2	$+49°$ 57·0	„ 7·5

No. 1 was observed on October 30, 1888, only. The spectrum strongly resembles that of *Mira*.

No. 2 was observed on several nights; on two the bright lines were thought doubtful, on one pretty certain.

No. 3.—Observed on several nights, and on each occasion the bright lines suspected.

Height of a Perseid Fireball. By W. F. Denning.

On August 13, 1888, at $11^h\ 33^m$, while watching for shooting stars, I saw a large fireball low in the northern sky. In the earlier part of its flight its magnitude was not considerable, but towards the end it suddenly blazed up with intense brilliancy, and illuminated the whole hemisphere with a flash like lightning. In the brighter part of its path a streak was left, and this remained perceptible about forty seconds. I carefully registered the visible arc of the meteor's course as follows: $113°+57\frac{1}{2}°$ to $126°+52\frac{1}{2}°$. This position lies between the constellations of *Ursa Major* and the *Lynx*, in a region comparatively bare of conspicuous stars.

Mr. David Booth at Leeds partially observed the phenomenon. He was looking towards the north-eastern sky for late Perseids when he was startled by a brilliant flash, which he immediately attributed to vivid lightning, but, on quickly turning round to the west, he noticed a very bright meteor streak projected amongst the stars of *Draco*. Its terminal points were $275°+67°$ and $260°+53°$, and he correctly assumed it to have been left by a fine Perseid. Though straight at first the streak soon became irregularly bent, and after a gradual decadence, occupying three minutes, it finally disappeared.

Mr. Monck at Dublin also saw the same meteor, and approximately noted its flight as from the direction of *β Persei* to 41 *Arietis*; but there were many clouds about in the region of its appearance, which rendered the observation a little uncertain.

He describes the fireball as exceptionally bright, and noticed the decided flash near its extinction.

Several observers at Birmingham and other places have furnished accounts of this object, but only in general terms, and they do not supply any precise data that may be employed in determining the fireball's real path in the atmosphere.

Mr. R. Parke Buckley, of Birmingham, writing on August 14, says, "I witnessed a most extraordinary occurrence in the sky at 11.30 last night. By the stars called Charles's Wain a comet, looking in the sky about 6 feet long by 2 feet, flashed suddenly on the stars forming the square part of the waggon, and lasted for about three minutes, gradually dying away." Mr. H. Basnett, of the same city, says that at 11.30 P.M. he saw what he thought was lightning, but it lasted too long. Everything around he could see quite plainly, as if it were daytime. Looking up at the sky, he noticed a long line of fire, and this lasted quite three minutes.

At Leeds and Bristol the enduring streak enabled the direction of the fireball's flight to be recorded with great precision; and when these observations are compared together they show a very satisfactory accordance. The radiant is indicated at $43°+56°$, near η *Persei*. This point was in azimuth N. 49° E., altitude 42° at the time of observation. At Bristol the streak extended from $121°+54\frac{3}{4}°$ to $126°+52\frac{1}{2}°$; and combining this with its apparent place as noted at Leeds, I find it was suspended vertically over Yorkshire at heights ranging from 59 miles (above a point two miles south of Grassington) to 47 miles (above Gisburn). Its length was 18 miles. But the nucleus of the fireball became visibly incandescent at a much earlier period of its flight through the air than that intimated by the streak, which simply marked the section of its course where it attained its highest degree of combustion and where its material became dissipated. When first seen at Bristol in $113°+57\frac{1}{2}°$ the meteor was situated above a point three miles north-east of Masham, in the North Riding of Yorkshire, and here it had an elevation of 78 miles. The whole observed path shows therefore a descent from 78 to 47 miles, as follows:

When first observed at Bristol	... ...	78 miles high
Beginning of light streak (Leeds and Bristol)	...	59 „ „
End of meteor and light streak (Leeds and Bristol)		47 „ „
Entire length of observed real path (Bristol)	...	46 „ „
Inclination to horizon (Leeds and Bristol)	...	42 degrees

The observation at Dublin, if included, would somewhat increase these heights, but the conditions prevailing there were unfavourable. The materials derived from Leeds and Bristol mutually corroborate the assigned path very closely, and they are sufficient for the present purpose.

Path and Heights of a Perseid Fireball, 1888, August 13, $11^h\ 33^m$ (W. F. D.).

This meteor was evidently typical of the large fireballs occasionally discharged by this well-known system. The radiant at $43°+56°$ is slightly erratic for the date. On the same night (August 13, 1888) the Perseid radiant was independently determined, from other meteors seen by myself, at $52°+57°$, and by Mr. Booth at $51\frac{1}{2}°+56°$. On August 13, 1885, I found it at $51°+58°$, and on August 13, 1880, at $49\frac{1}{2}°+57\frac{1}{2}°$. The mean of all these is at $51°+57°$, which is 4° east of the fireball radiant. The difference is not large, but it can scarcely be accounted for by errors of observation, as they are likely to have been almost nil. The fireball itself was probably discordant to the extent referred to, for the Perseid radiant was not nearly as well defined as usual this year. There appear to be annual variations, not only in the richness of the display, but in the character of its radiation. In some years it is very precise, in others its diffusion is equally marked.

Bristol: 1888, *October* 15.

A Table of the Positions of Observatories, with Constants useful in Correcting Extra-Meridian Observations for Parallax. By Lieut.-General Tennant, R.E., F.R.S.

The discontinuance of old Observatories and the formation of new ones renders the occasional revision of such tables as the present one desirable. The extension of the electric telegraph has facilitated the determination of longitudes, so that the results recently published may be considered practically perfect as regards both elements of position: I hope therefore that the places I now give may require, except in one or two cases, little amendment.

Starting with Mr. Lancaster's "Liste Générale," I have omitted some Observatories which never should have been admitted as astronomical establishments, such as Calcutta and Bombay. Then I have examined the positions with the *Berliner Jahrbuch*, *Connaissances des Temps*, *Nautical Almanac*, and *American Nautical Almanac*, preferring each authority for the places of its own nation. A few corrections have been made from the *Monthly Notices* and other sources, and some new Observatories have been added, as well as some omitted, which I had no reason to suppose were very active. For the places of Mr. Brooks's new Observatory (Smith Observatory) at Geneva I am indebted to that gentleman. But I have not been able to get the position of the new Dearborn Observatory, and we now hear that the establishment at Edinburgh is to be moved, but it is useless to wait till changes cease.

In computing the constants I have used Col. Ross Clarke's figure of the Earth, which is certainly the best known, and I have used 8″·78 for the Mean Solar Parallax. The table is otherwise only a recomputation and slight extension of the corresponding one in Oppolzer's *Lehrbuch*, vol. i. The figure of the Earth makes but slight changes, but it is otherwise with the Solar Parallax. The value I have taken is a very small one, so that a constant addition to the last three logarithms will correct to any value likely to be preferred: Newcomb's parallax requires an addition of 0·0034.

The formulæ I have used are Oppolzer's:

$$\tan\phi_1 = \frac{b}{a}\tan\phi \;:\; \tan\phi' = \frac{b}{a}\tan\phi_1;\quad \log\frac{a}{b} = 9{\cdot}99851\,76.$$

$$A = \frac{\pi}{15}\cos\phi_1;\quad D = \pi.\frac{b}{a}\sin\phi_1;$$

and I have added

$$P = \pi.\frac{\cos\phi_1}{\cos\phi'} = h\pi \text{ of Oppolzer,}$$

which is used to correct the solar places in computing orbits.

If θ be the Sidereal Time, α and δ the true, and α' and δ' the observed, Right Ascensions and Declinations, then

$$\tan\gamma = \frac{\tan\phi'}{\cos(\theta-\alpha')}\,;\quad \alpha-\alpha' = \frac{A}{\rho}\frac{\sin(\theta-\alpha')}{\cos\delta'}\,;\quad \delta-\delta' = \frac{D}{\rho}\frac{\sin(\gamma-\delta')}{\sin\gamma}.$$

A practice has arisen (largely followed in the United States) of calling an observatory after some person whom it is desired to commemorate. The result is not always convenient. I have however generally used these names in the following table, and add a list of synonyms for the purpose of further identifying places of observation.

The Observatory	at Albany	is	Dudley Observatory.
,,	,, Amherst	,,	Lawrence ,,
,,	of Michigan University	,,	Ann Arbor ,,
,,	at Cambridge, U.S.	,,	Harvard Coll. ,,
,,	,, Chicago	,,	Dearborn ,,
,,	,, Clinton, N.Y.	,,	Litchfield ,,
,,	,, Glasgow (Miss.)	,,	Morrison ,,
,,	,, Evanston Isle	,,	New Dearborn ,,
The Dartmouth Observatory		,,	at Hanover.
The Observatory	at Madison (Wis.)	,,	Washburn Observatory.
,,	,, Mount Hamilton	,,	Lick ,,
,,	,, New Haven	,,	Winchester ,,
,,	of Columbia College	,,	at New York.
,,	at Northfield	,,	Carleton Coll. ,,
The Radcliffe Observatory		,,	at Oxford.
,,	Vassar College Observatory	,,	at Poughkeepsie.
The Observatory	at Richmond (Virg.)	,,	Leander McCormick Observatory.
,,	,, Rochester	,,	Warner Observatory.
,,	,, South Bethlehem	,,	Sayre ,,
,,	of Vanderbilt University	is	at Nashville.

P.S.—I have thought it best to give the new place of Dearborn Observatory from Keith Johnston's place of Evanston, correcting for error of longitude of Chicago. It will serve better for reducing observations than the old value, though it is not accurate.

Positions of Observatories and Constants for Parallaxes.

Names.	Longitudes from Greenwich. Time. h m s	Parts of Day. d	Correction to S.T.M.N. s	Latitudes. ° ′ ″	Constants. tan ϕ'.	log A.	log D.	log P.	
Adelaide	+ 9 14 21·3	+0·384969	−91·06	−34 35 34	9·8411$_n$	9·6816	0·6987$_n$	0·9430	
Alfred Centre	− 5 11 07·0	−0·216053	+51·11	+42 15 20	9·9554	9·6374	0·7688	0·9428	
Algiers	+ 0 12 16·9	+0·008529	− 2·02	+36 44 00	9·8699	9·6718	0·7178	0·9430	
Allegheny	− 5 20 02·9	−0·222256	+52·58	+40 27 42	9·9279	9·6493	0·7533	0·9429	
Annapolis	− 5 05 56·4	−0·212458	+50·26	+38 58 54	9·9051	9·6586	0·7398	0·9429	Naval Acad.
Ann Arbor (Mich.) ...	− 5 34 55·1	−0·232582	+55·02	+42 16 48	9·9557	9·6372	0·7690	0·9428	Near Detroit
Antwerp	+ 0 17 38·6	+0·012252	− 2·90	+51 12 28	0·0919	9·5652	0·8332	0·9426	A. de Boë
Arcetri	+ 0 45 03·1	+0·031286	− 7·40	+43 45 14	9·9781	9·6268	0·7811	0·9428	Near Florence
Armagh	− 0 26 35·5	−0·018466	+ 4·37	+54 21 13	0·1414	9·5339	0·8514	0·9424	
Athens	+ 1 34 54·9	+0·065913	−15·59	+37 58 20	9·8894	9·6647	0·7302	0·9429	
Beloit Coll. (Wis.) ...	− 5 56 07·3	−0·247307	+58·50	+42 30 09	9·9591	9·6357	0·7709	0·9428	Smith Observatory
Bergen	+ 0 21 13·0	+0·014734	− 3·49	+60 23 54	0·2426	9·4622	0·8809	0·9424	
Berlin	+ 0 53 34·9	+0·037210	− 8·80	+52 30 17	0·1121	9·5527	0·8409	0·9426	
Berne	+ 0 29 45·7	+0·020667	− 4·89	+46 57 09	0·0267	9·6024	0·8051	0·9427	
Besançon	+ 0 23 57·2	+0·016634	− 3·93	+47 14 59	0·0312	9·5999	0·8072	0·9427	
Bilk	+ 0 27 05·0	+0·018808	− 4·45	+51 12 25	0·0919	9·5652	0·8332	0·9426	Near Düsseldorf
Birr Castle	− 0 31 40·9	−0·022001	+ 5·20	+53 05 47	0·1214	9·5468	0·8444	0·9425	Lord Rosse
Bologna	+ 0 45 24·9	+0·031538	− 7·46	+44 29 47	9·9894	9·6214	0·7869	0·9428	
Bonn	+ 0 28 23·3	+0·019714	− 4·66	+50 43 45	0·0845	9·5697	0·8302	0·9426	

Names.	Longitudes from Greenwich. Time.	Parts of Day.	Correction to S.T.M.N.	Latitudes.	tan ϕ'.	Constants. log A.	log D.	log P.	
	h m s	d	s	° ′ ″					
Bordeaux...	− 0 02 05·4	−0·001451	+ 0·35	+44 50 07	9·9945	9·6189	0·7895	0·9428	
Bothkamp	+ 0 40 31·2	+0·028197	− 6·66	+54 12 10	0·1390	9·5355	0·8506	0·9425	Baron von Bülow
Breslau	+ 1 08 08·9	+0·047325	−11·20	+51 06 57	0·0905	9·5661	0·8326	0·9426	
Brussels	+ 0 17 28·7	+0·012138	− 2·87	+50 51 11	0·0864	9·5685	0·8310	0·9426	
Buda Pesth	+ 1 16 15·4	+0·052956	−12·53	+47 29 35	0·0349	9·5979	0·8089	0·9427	Also Ofen
Cambridge	+ 0 00 22·8	+0·000264	− 0·06	+52 12 52	0·1076	9·5556	0·8392	0·9426	
Cape of Good Hope ...	+ 1 13 54·7	+0·051328	−12·14	−33 56 03	$9·8249_n$	9·6968	$0·6878_n$	0·4930	
Carleton College... ...	− 6 12 36	−0·258750	+61·21	+44 27 41	9·9889	9·6217	0·7866	0·9428	Northfield (Min.)
Carlsruhe	+ 0 33 36·5	+0·023339	− 5·52	+49 00 30	0·0580	9·5851	0·8192	0·9426	
Chabot	− 8 00 06·3	−0·333406	+78·87	+37 48 05	9·8867	9·6657	0·7285	0·9429	California Univ.
Chapultepec	− 6 36 38·2	−0·275442	+65·16	+19 25 18	9·5443	9·7420	0·4624	0·9432	Near Mexico
Christiania	+ 0 42 53·8	+0·029789	− 7·05	+59 54 44	0·2341	9·4686	0·8788	0·9424	
Cincinnati	− 5 37 41·3	−0·234506	+55·47	+39 08 20	9·9076	9·6576	0·7413	0·9429	
Coimbra	− 0 33 34·1	−0·023311	+ 5·51	+40 12 26	9·9240	9·6509	0·7511	0·9429	
Cologne	+ 0 27 51	+0·019340	− 4·58	+50 55 31	0·0875	9·5679	0·8315	0·9426	Dr. Klein
Copenhagen	+ 0 50 18·9	+0·034941	− 8·27	+55 41 13	0·1629	9·5195	0·8585	0·9425	
Cordoba	− 4 16 48·2	−0·178336	+42·19	−31 25 15	$9·7830_n$	9·6989	$0·6580_n$	0·9431	
Cracow	+ 1 19 50·4	+0·055444	−13·11	+50 03 50	0·0742	9·5758	0·8261	0·9426	
Dantzig	+ 1 14 39·6	+0·051847	−12·16	+54 21 18	0·1414	9·5339	0·8514	0·9425	
Dearborn (Old)	− 5 50 27·1	−0·243369	+57·57	+41 50 01	9·9489	9·6403	0·7653	0·9428	Chicago (U.S.)

Names.	Longitudes from Greenwich. Time. h m s	Parts of Day. d	Correction to S.T.M.N. s	Latitudes. ° ′ ″	Constants. tan ϕ'.	log A.	log D.	log P.	
Dearborn (New) ...	− 5 51 00	−0·243750	+57·66	+42 05	9·9527	9·6386	0·7674	0·9428	Evanston (Ill.)
Dorpat	+ 1 46 53·6	+0·074231	−17·56	+58 22 47	0·2077	9·4880	0·8718	0·9424	
Dresden	+ 0 54 54·8	+0·038134	− 9·02	+51 02 17	0·0893	9·5668	0·8322	0·9426	Baron v. Englehardt
Dublin	− 0 25 22	−0·017616	+ 4·16	+53 23 13	0·1260	9·5439	0·8460	0·9425	Dunsink
Dudley	− 4 54 59·7	−0·204858	+48·46	+42 39 50	9·9616	9·6346	0·7722	0·9428	Albany (N.Y.)
Dunecht	− 0 09 40·0	−0·006713	+ 1·59	+57 09 36	0·1872	9·5027	0·8660	0·9424	Lord Crawford
Durham	− 0 06 19·8	−0·004396	+ 1·04	+54 46 06	0·1481	9·5295	0·8536	0·9424	
Ealing	− 0 01 13	−0·000845	+ 0·20	+51 31 07	0·0967	9·5623	0·8351	0·9426	A. A. Common
Edinburgh	− 0 12 43·6	−0·008826	+ 2·09	+55 57 23	0·1673	9·5165	0·8599	0·9425	
Florence	+ 0 45 01·9	+0·031272	− 7·40	+43 46 04	9·9783	9·6267	0·7812	0·9428	Museum
Frankfurt	+ 0 34 47·1	+0·024156	− 5·71	+50 07 03	0·0750	9·5753	0·8264	0·9426	Dr. Epstein
Geneva	+ 0 24 36·8	+0·017093	− 4·04	+46 11 59	0·0152	9·6084	0·7997	0·9427	
Genoa	+ 0 35 41·4	+0·027525	− 5·86	+44 25 09	9·9882	9·6220	0·7863	0·9428	Naval Obs.
Georgetown (D.C.) ...	− 5 08 18·2	−0·214101	+50·65	+38 54 26	9·9040	9·6590	0·7391	0·9429	
Glasgow	− 0 17 10·6	−0·011928	+ 2·82	+55 52 43	0·1661	9·5173	0·8595	0·9425	
Göhlis	+ 0 49 29·6	+0·034370	− 8·13	+51 21 35	0·0942	9·5638	0·8341	0·9426	Herr Winkler
Gotha	+ 0 42 50·6	+0·029752	− 7·04	+50 56 38	0·0878	9·5677	0·8316	0·9426	
Göttingen	+ 0 39 46·4	+0·027620	− 6·53	+51 31 48	0·0969	9·5622	0·8352	0·9426	
Grätz	+ 1 01 47·9	+0·042916	−10 15	+47 04 37	0·0285	9·6013	0·8060	0·9427	
Greenwich	0 00 00·0	0·000000	0·00	+51 28 38	0·0961	9·5627	0·8348	0·9426	

Names.	Longitudes from Greenwich. Time. h m s	Parts of Day. d	Correction to S.T.M.N. s	Latitudes. ° ′ ″	tan ϕ'.	Constants. log A.	log D.	log P.	
Grignon	+ 0 17 37·9	+0·012244	− 2·90	+47 33 42	0·0359	9·5974	0·8094	0·9427	
Halifax	− 0 07 28	−0·005185	+ 1·23	+53 42 09	0·1310	9·5497	0·8478	0·9425	E. Crossley
Hamburg	+ 0 39 53·8	+0·027706	− 6·55	+53 33 07	0·1287	9·5422	0·8470	0·9425	
Hanover (N.H.)	− 4 49 08·0	−0·200787	+47·50	+43 42 15	9·9774	9·6272	0·7807	0·9428	
Harrow (Hill Foot) ...	− 0 01 19·9	−0·000925	+ 0·22	+51 34 47	0·0977	9·5617	0·8355	0·9426	Col. Tupman
Harvard Coll. Obs. ...	− 4 44 31·0	−0·197581	+46·74	+42 22 48	9·9573	9·6365	0·7699	0·9428	Cambridge (Mass.)
Haverford (N.J.)(Coll.Obs.)	− 5 01 12·7	−0·209175	+49·48	+40 00 40	9·9210	9·6522	0·7493	0·9429	
Heidelberg	+ 0 34 48·5	+0·024172	− 5·72	+49 24 35	0·0642	9·5816	0·8218	0·9426	
Helsingfors	+ 1 39 49·2	+0·069319	−16·39	+60 09 43	0·2384	9·4653	0·8799	0·9424	
Herény	+ 1 06 24·7	+0·046119	−10·91	+47 15 47	0·0314	9·5998	0·8073	0·9427	Von Gothard
Hudson	− 5 25 44·2	−0·226206	+53·51	+41 14 43	9·9400	9·6442	0·7602	0·9428	
Juvisy	+ 0 09 29	+0·006586	− 1·56	+48 41 36	0·0532	9·5878	0·8171	0·9427	C. Flammarion
Kalocsa	+ 1 15 55·7	+0·052728	−12·47	+46 31 41	0·0202	9·6058	0·8021	0·9427	Card. Haynald
Kasan	+ 3 16 29·1	+0·136448	−32·28	+55 47 24	0·1646	9·5183	0·8590	0·9425	
Kempshott (Jam.) ...	− 5 11 10	−0·216088	+51·12	+18 24 51	9·5194	9·7447	0·4402	0·9433	M. Hall
Kharkoff	+ 2 24 54·7	+0·100633	−23·80	+50 00 10	0·0733	9·5763	0·8257	0·9426	
Kieff	+ 2 02 00·7	+0·084730	−20·04	+50 27 11	0·0802	9·5722	0·8285	0·9426	
Kiel	+ 0 40 35·7	+0·028191	− 6·67	+54 20 29	0·1412	9·5340	0·8513	0·9425	
Königsberg	+ 1 21 59·1	+0·056934	−13·47	+54 42 51	0·1472	9·5301	0·8533	0·9425	

Names.	Longitudes from Greenwich. Time. h m s	Parts of Day. d	Correction to S.T.M.N. s	Latitudes. ° ′ ″	tan ϕ'.	Constants. log A.	log D.	log P.	
Kremsmunster	+ 0 56 31·6	+0·039255	− 9·29	+48 03 24	0·0435	9·5932	0·8128	0·9427	
Kuffner Obs.	+ 1 05 11·1	+0·045267	−10·71	+48 12 48	0·0459	9·5919	0·8139	0·9427	Ottakring (Vienna)
La Plata	− 3 51 37	−0·161539	+39·59	−34 54 30	$9·8408_n$	9·6817	$0·6986_n$	0·9430	
Launceston (Tasm.) ...	+ 9 48 31	+0·408692	−96·68	−41 26 01	$9·9428_n$	9·6429	$0·7619_n$	0·9428	A. B. Biggs
Lawrence Obs.	− 4 50 04·7	−0·201443	+47·65	+42 22 17	9·9571	9·6366	0·7698	0·9428	Amherst (Mass.)
Leander McCormick Obs.	− 5 14 00·7	−0·218064	+51·58	+38 02 01	9·8904	9·6643	0·7308	0·9429	Richmond (Vir.)
Leiden	+ 0 17 56·4	+0·012458	− 2·95	+52 09 20	0·1067	9·5561	0·8389	0·9426	
Leipzig	+ 0 49 34·0	+0·034422	− 8·14	+51 20 06	0·0939	9·5640	0·8340	0·9426	University Obs.*
Lick	− 8 06 34·1	−0·337895	+79·93	+37 20 23	9·8795	9·6684	0·7240	0·9430	Mt. Hamilton (Cal.)
Lisbon	− 0 36 44·7	−0·025518	+ 6·04	+38 42 31	9·9009	9·6603	0·7372	0·9429	
Litchfield Obs.	− 5 01 37·4	−0·209461	+49·55	+43 03 17	9·9675	9·6318	0·7754	0·9428	Clinton (N.Y.)
Louvain	+ 0 18 51·0	+0·013090	− 3·09	+50 52 40	0·0868	9·5683	0·8312	0·9426	Dr. Terby
Lübeck	+ 0 42 45·7	+0·029696	− 7·02	+53 51 31	0·1335	9·5391	0·8487	0·9425	
Lund	+ 0 52 45·0	+0·036632	− 8·67	+55 41 52	0·1631	9·5193	0·8586	0·9425	
Lyons	+ 0 19 07·9	+0·013286	− 3·14	+45 41 40	0·0076	9·6123	0·7960	0·9427	
Madras	+ 5 20 59·3	+0·222910	−52·73	+13 04 08	9·3628	9·7561	0·2949	0·9434	
Madrid	− 0 14 45·1	−0·010244	+ 2·42	+40 24 30	9·9271	9·6497	0·7529	0·9429	

* Same quantities for Dr. Engelmann's Observatory.

Names.	Longitudes from Greenwich. Time. h m s	Parts of Day. d	Correction to S.T.M.N. s	Latitudes. ° ′ ″	tan ϕ'.	Constants. log A.	log D.	log P.	
Markree	− 0 33 48·4	−0·023477	+ 5·55	+ 54 10 32	0·1386	9·5358	0·8504	0·9425	Col. Cooper
Marseilles	+ 0 21 34·6	+0·014984	− 3·54	+43 18 19	9·9713	9·6290	0·7775	0·9428	
Melbourne	+ 9 39 53·4	+0·402701	−95·26	−37 49 53	$9·8872_n$	9·6655	$0·7288_n$	0·9429	
Mexico	− 6 36 26·6	−0·275308	+65·13	+19 26 01	9·5446	9·7421	0·4628	0·9433	
Milan	+ 0 36 46·0	+0·025532	− 6·04	+45 27 59	0·0041	9·6141	0·7943	0·9427	
Modena	+ 0 43 42·9	+0·030358	− 7·18	+44 38 53	9·9917	9·6203	0·7881	0·9428	
Moncalieri	+ 0 30 49	+0·021399	− 5·06	+44 59 51	9·9970	9·6176	0·7907	0·9427	Near Turin
Morrison Obs.	− 6 11 18·0	−0·257847	+61·00	+39 13 46	9·9090	9·6571	0·7421	0·9429	Glasgow (Miss.)
Moscow	+ 2 30 17·2	+0·104366	−24·69	+55 45 20	0·1641	9·5187	0·8589	0·9425	
Munich	+ 0 46 26·1	+0·032247	− 7·63	+48 08 45	0·0448	9·5925	0·8134	0·9427	
Naples	+ 0 57 00·5	+0·039589	− 9·36	+40 51 45	9·9341	9·6467	0·7569	0·9429	Capo di Monte
Nashville (Tenn.) ...	− 5 47 08·0	−0·241065	+57·03	+36 08 58	9·8607	9·6750	0·7118	0·9430	Vanderbilt Univ.
Natal	+ 2 02 01·2	+0·084736	−20·04	−29 50 47	$9·7558_n$	9·7060	$0·6378_n$	0·9431	
Neuchatel	+ 0 27 49·9	+0·019328	− 4·57	+47 00 01	0·0274	9·6020	0·8054	0·9427	
New York (Col. Coll.) ...	− 4 55 53·6	−0·205481	+48·61	+40 45 23	9·9325	9·6474	0·7560	0·9429	
„ (Ruth.) ...	− 4 55 57·0	−0·205520	+48 62	+40 43 48	9·9321	9·6476	0·7557	0·9429	L. Rutherford
Nice	+ 0 29 12·3	+0·020281	− 4·80	+43 43 17	9·9776	9·6271	0·7808	0·9428	Montgros
Nicolaieff	+ 2 07 53·9	+0·088818	−21·01	+46 58 21	0·0270	9·6022	0·8052	0·9427	
Odessa	+ 2 03 02·4	+0·085444	−20·21	+46 28 36	0·0194	9·6062	0·8017	0·9427	

Names.	Longitudes from Greenwich. Time. h m s	Parts of Day. d	Correction to S.T.M.N. s	Latitudes. ° ′ ″	tan ϕ'.	Constants. log A.	log D.	log P.	
O'Gyalla	+ 1 12 45·6	+0·050528	−11·95	+47 52 27	0·0407	9·5948	0·8115	0·9427	Dr. von Konkoly
Orwell Park	+ 0 04 55·8	+0·003424	− 0·81	+52 00 33	0·1044	9·5576	0·8380	0·9426	Col. Tomline
Ougrée	+ 0 22 12	+0·015417	− 3·65	+50 37 06	0·0828	9·5707	0·8296	0·9426	Near Liège
Oxford (Radcliffe Obs.)...	− 0 05 02·6	−0·003502	+ 0·83	+51 45 36	0·1005	9·5600	0·8365	0·9426	
„ (University Obs.)	− 0 05 00·4	−0·003477	+ 0·82	+51 45 34					
„ (Mississippi) ...	− 5 58 07·1	−0·248693	+58·83	+34 22 13	9·8321	9·6845	0·6927	0·9430	
Padua	+ 0 47 29·2	+0·032977	− 7·80	+45 24 02	0·0031	9·6146	0·7938	0·9426	
Palermo	+ 0 53 24·7	+0·037091	− 8·77	+38 06 44	9·8916	9·6638	0·7315	0·9429	
Paris	+ 0 09 21·0	+0·006492	− 1·54	+48 50 11	0·0554	9·5866	0·8181	0·9426	
Philadelphia	− 5 00 38·5	−0·208779	+49·39	+39 57 07	9·9201	9·6526	0·7488	0·9429	
Plonsk	+ 1 21 32	+0·056620	−13·39	+52 37 39	0·1141	9·5515	0·8417	0·9426	Dr. Jedrzejewicz
Pola	+ 0 55 23·2	+0·038463	− 9·10	+44 51 49	9·9950	9·6186	0·7897	0·9427	
Potsdam	+ 0 52 15·9	+0·036295	− 8·58	+52 22 55	0·1102	9·5539	0·8402	0·9426	
Poughkeepsie (N.Y.) ...	− 4 55 33·6	−0·205250	+48·55	+41 41 18	9·9467	9·6412	0·7640	0·9428	
Poulkova	+ 2 01 18·6	+0·084243	−19·93	+59 46 19	0·2316	9·4705	0·8782	0·9422	
Prague	0 57 41·5	+0·040064	− 9·48	+50 05 18	0·0746	9·5755	0·8262	0·9426	I.R. Observatory
„	0 57 47	+0·040127	− 9·49	+50 04 25	0·0744	9·5757	0·8261	0·9426	Prof. Safarik
Princeton (N.J.) ...	− 4 58 37·5	−0·207378	+49·06	+40 20 58	9·9262	9·6500	0·7523	0·9429	
Providence (R.I.) ...	− 4 45 37·6	−0·198352	+46·92	+41 49 46	9·9489	9·6403	0·7653	0·9428	F. E. Seagrave

Names.	Longitudes from Greenwich. Time. h m s	Parts of Day. d	Correction to S.T.M.N. s	Latitudes. ° ′ ″	tan ϕ.	Constants. log A.	log D.	log P.	
Puebla (Mexico)... ...	− 6 32 41	−0·272697	+64·50	+19 02 30	9·5350	9·7431	0·4542	0·9433	
Rio de Janeiro	− 2 52 41·4	−0·119924	+28·37	−22 54 24	$9·6229_n$	9·7319	$0·5310_n$	0·9433	
Rome (Coll. Rom.) ...	+ 0 49 55·5	+0·034670	− 8·20	+41 53 54	9·9499	9·6398	0·7658	0·9428	
„ (Capitol)	+ 0 49 56·5	+0·034682	− 8·20	+41 53 33	9·9498	9·6399	0·7658	0·9428	
St. Louis (Miss.) ...	− 6 00 49·1	−0·250568	+59·27	+38 38 04	9·8997	9 6607	0·7365	0·9429	
St. Petersburg	+ 2 01 11·4	+0·084160	−19·91	+59 56 32	0·2346	9·4682	0·8789	0·9424	University
San Fernando	− 0 24 49·2	−0·017236	+ 4·08	+36 27 41	9·8656	9·6733	0·7150	0·9430	
San Francisco (Cal.) ...	− 8 09 42·5	−0·340075	+80·46	+37 47 24	9·8866	9·6657	0·7284	0·9429	G. Davidson
Santiago (Chili) ...	− 4 42 46·3	−0·196369	+46·45	−33 26 42	9·8169	9·6892	0·6822	0·9430	
Sayre Observatory ...	− 5 01 31·9	−0·209397	+49·53	+40 36 24	9·9302	9·6484	0·7546	0·9429	S. Bethlehem
Scarborough	− 0 01 38·9	−0·001145	+ 0·27	+54 16 30	0·1402	9·5347	0·8510	0·9425	R. Wigglesworth
Smith Obs., Geneva (N.Y.)	− 5 08 00	−0·213889	+50·60	+42 53 00	9·9649	9·6330	0 7740	0·9427	W. R. Brooks
South Hadley	− 4 50 20·3	−0·201624	+47·70	+42 15 18	9 9554	9·6374	0·7688	0·9428	
Stockholm	+ 1 12 14·0	+0·050162	−11·87	+59 20 34	0·2242	9·4760	0·8762	0·9424	
Stonyhurst	− 0 09 52·7	−0·006860	+ 1·62	+53 50 40	0·1333	9·5392	0·8486	0·9425	
Strasburg	+ 0 31 04·7	+0·021582	− 5·11	+48 35 00	0·0515	9·5888	0·8164	0·9428	
Sydney (N.S.W.) ...	+10 04 48·5	+0·420006	−99·35	−33 51 41	$9·8238_n$	9·6871	$0·6870_n$	0·9430	
Tacubaya	− 6 36 46·5	−0·275538	+65·18	+19 24 17	9·5439	9·7422	0·4621	0·9433	
Tashkent...	+ 4 37 10·8	+0·192486	−45·54	+41 19 32	9·9412	9·6437	0·7609	0·9428	

Names.	Longitudes from Greenwich. Time. h m s	Parts of Day. d	Correction to S.T.M.N. s	Latitudes. ° ′ ″	tan ϕ'.	Constants. log A.	log D.	log P.	
Toulouse	+ 0 05 51·0	+0·004063	− 0·96	+43 36 45	9·9760	9·6279	0·7799	0·9428	
Trieste	+ 0 55 02·1	+0·038219	− 9·04	+45 38 34	0·0068	9 6127	0·7956	0·9427	
Tulse Hill	− 0 00 27·7	−0·000321	+ 0·08	+51 26 47	0·0956	9·5630	0·8346	0·9426	Dr. W. Huggins
Turin	+ 0 30 47·2	+0·021380	− 5·06	+45 04 08	9·9981	9 6171	0·7913	0·9427	
Upsala	+ 1 10 30·2	+0·048961	−11·58	+59 51 29	0·2331	9·4693	0·8785	0·9424	
Urbino	+ 0 50 33·1	+0·035105	− 8·30	+43 43 30	9·9777	9·6270	0·7808	0·9428	
Utrecht	+ 0 20 31·7	+0·014256	− 3·37	+52 05 09	0·1056	9·5568	0·8385	0·9426	
Venice	+ 0 49 25·8	+0·034326	− 8·12	+45 25 49	0·0036	9·6143	0·7940	0·9427	
Vienna	+ 1 05 21·5	+0·045388	−10·74	+48 13 55	0·0461	9·5918	0·8140	0·9427	Imp. Obs.
Warner Observatory ...	− 5 10 21 8	−0·215530	+50·99	+43 09 17	9·9690	9·6311	0·7763	0·9482	Rochester, N.Y.
Warsaw	+ 1 24 07·3	+0·058418	−13·82	+52 13 06	0·1076	9·5555	0·8393	0·9426	
Washburn Observatory...	− 5 57 36·2	−0·248355	+58·75	+43 04 37	9 9679	9·6317	0·7756	0·9428	Madison (Wis.)
Washington	− 5 08 12·0	−0·214028	+50·63	+38 53 39	9·9038	9·6591	0·7390	0·9429	
Wilhelmshaven	+ 0 32 35·2	+0·022630	− 5·35	+53 31 52	0·1283	9·5424	0·8468	0·9425	
Williamstown (Mass.) ...	− 4 52 53·4	−0·203396	+48·11	+42 42 49	9·9623	9 6342	0·7726	0·9428	
Wilna	+ 1 41 09·0	+0·070243	−16 62	+54 40 59	0·1467	9·5304	0·8532	0·9425	
Winchester Observatory	− 4 51 42·1	−0·202571	+47·92	+41 18 37	9·9409	9·6438	0·7608	0·9428	New Haven (Conn.)
Windsor (N.S.W.) ...	+10 03 19·2	+0·418972	−99·11	−33 36 31	$9·8196_n$	9·6884	$0·6841_n$	0·9430	J. Tebbutt
Zürich	+ 0 34 12·4	+0·023755	− 5·62	+47 22 40	0·0331	9·5989	0·8081	0·9427	

Observations of Comet a 1888 (*Sawerthal*), *made at the Radcliffe Observatory, Oxford.*

(*Communicated by E. J. Stone, M.A., F.R.S., Radcliffe Observer.*)

The following observations of Comet Sawerthal were made with the Barclay equatorial, using the ring-micrometer, with power 100. On account of the faintness of the comet the observations were very difficult, and the probable errors of the results must therefore be regarded as much larger than those of the earlier series.

1888.	Greenwich Mean Time.	Observer.	Comet−Star Δ R.A. (Corrected for Refraction only.)	Comet−Star Δ N.P.D. (Corrected for Refraction only.)	No. of Comps.	Apparent R.A. of Comet.	Log $p\,\Delta$	Apparent N.P.D. of Comet.	Log $p\,\Delta$	Comp. Star.
	h m s		m s	′ ″		h m s		° ′ ″		
July 3	11 25 22	W.	−0 15·99	−2 52·07	4	1 3 3·58	9·4065	41 29 53·3	0·4185	1
5	11 7 27	F. B.	−3 50·00	−5 34·39	5	1 4 9·22	9·4029	41 4 25·6	0·4295	2
12	11 3 1	R.	+0 15·10	+5 37·53	12	1 7 5·18	9·4196	39 38 56·9	0·3870	3
Aug. 8	12 4 3	W.	−1 2·63	−1 1·62	12	0 59 49·44	9·3798	35 36 50·6	9·8646	4

Assumed Places of Comparison Stars.

Comp. Star.	Mean R.A. 1888·0.	Reduction to Apparent Place.	Mean N.P.D. 1888·0.	Reduction to Apparent Place.	Authority.
	h m s	s	° ′ ″	″	
1	1 3 18·57	+1·00	41 32 34·15	+11·21	Mean of Radcliffe I. 347, Oeltz. Arg. (N.) 1155, and Lalande 2011.
2	1 7 58·17	+1·05	41 9 48·87	+11·11	Mean of Radcliffe I. 379 and Paris 1566.
3	1 6 48·70	+1·38	39 33 8·96	+10·38	Oeltz. Arg. (N.) 1236.
4	1 0 49·18	+2·89	35 37 46·08	+ 6·18	Mean of Radcliffe I. 329 and Greenwich (1872) 103, adopting proper motions of +0ˢ·386 in R.A., and +1″·56 in N.P.D.

Observers' Remarks.

1888, July 3.—Clouds keep passing. Tail estimated at 8′ in length, but nucleus only glimmers out now and then; end of luminosity observed. The "wing" appendages seen on May 23 have disappeared.

July 5.—Nucleus showed up at times, and was then as bright as an 11th magnitude star. The nucleus was observed when visible. Clouds were continually passing.

July 12.—The nucleus exceedingly faint, and only seen occasionally. Observations very difficult.

August 8.—Night exceptionally fine. When the eye became accustomed to the field, which was rich with small stars, the comet could be distinguished as very faint luminous haze. Occasionally a coma showed itself as a brightening near the head of the luminosity.

Observers: W., Mr. W. Wickham; R., Mr. W. H. Robinson; F. B., Mr. F. A. Bellamy.

Radcliffe Observatory, Oxford:
1888, *November* 8.

Observations of Comet e 1888 (*Barnard*), *made at Stonyhurst College Observatory.* By the Rev. W. J. Crofton, S.J., B.A.

(*Communicated by the Rev. S. J. Perry.*)

1888.	Stonyhurst Mean Time.	✱−𝒻 R.A.	✱−𝒻 N.P.D.	No. of Comps.	Comp. Star.
	h m s	s	′ ″		
Oct. 12	16 6 29	+37·71	−13 29·0	10	*a*
„ 13	15 28 20	− 0·60	− 9 54·0	9	*b*

Mean Places of Comparison Stars.

Comp. Star.	R.A. 1888·0.	N.P.D. 1888·0.	Authority.
	h m s	° ′ ″	
a	6 23 46·86	82 46 53·2	Lal. 12434
b	6 21 18·70	82 59 53·4	W.B. VI. 579

Observers: W. J. Crofton and W. Carlisle.

The observations were taken over two bars at right angles and inclined at 45° to the declination circle. The corrections for refraction and parallax have been applied.

The comet presented a starry nucleus (estimated 10–11 mag.), surrounded by a round nebulosity, but without tail. On the 12th, what appeared a 10th mag. star was perceived through the body of the comet, towards the edge. It was not seen on the 13th.

Observations of Jupiter's Satellites made at the Stonyhurst Observatory. By the Rev. S. J. Perry, D.Sc., F.R.S.

	Sat.	Phenomena.	G. M. T. h m s	Corr. to N. A.	Observer.	Remarks.
1886, April 11	III.	Tr. Ingress, ext. cont.	9 48 17·3		S. J. P.	Definition fair.
		bisection	9 51 47·6		"	
		int. cont.	9 55 48·8		"	
	III.	Tr. Egress, int. cont.	12 34 50·6		W. C.	Sky covered with thin clouds.
		bisection	12 37 16·1		"	
		ext. cont.	12 40 49·1		"	
29	III.	Occ. Reapp. bisection	9 21 31·8		"	Very unsteady.
		last cont.	0 24 52·3		"	
	III.	Ec. Disapp. ½ light	9 59 23·5		S. J. P.	Good.
		v. faint	10 2 15·8		"	Boiling.
		last seen	10 3 23·3	m s +4 23·3	"	"
	III.	Ec. Reapp. first seen	12 40 53·4	−0 29·6	W. C.	Good.
		½ light	12 44 56·9		"	Compared with I.
		full light	12 49 6·9		"	
30	IV.	Occ. Reapp. first seen	9 55 26·8		"	Definition very bad.
		bisection	10 4 27·8		"	
		last cont.	10 13 8·9		"	

	Sat.	Phenomena.	G. M. T. h m s	Corr. to N. A. m s	Observer.	Remarks.
May 6	III.	Oc. Reapp. bisection	12 50 43·5		W. C.	
		last cont.	12 55 24·0		,,	
	III.	Ec. Disapp. last seen	13 58 16·5	+0 21·5	,,	
	III.	Oc. Disapp. first cont.	9 55 3·5		,,	
		bisection	9 58 43·5		,,	
		last cont.	10 2 30·5		,,	
June 5	II.	Ec. Reapp. first seen	12 13 41·5	+0 15·5	,,	
		full light	12 17 10		,,	
Dec. 28	II.	Oc. Reapp bisection	17 1 5·8		,,	Definition pretty good.
		last. cont.	17 5 4		,,	
1887, Jan. 19	III.	Ec. Reapp., first seen	15 16 18·5	−1 35·5	,,	Sky hazy.
		½ light	15 20 43·0		,,	
		full light	15 24 5·0		,,	
March 3	III.	Ec. Disapp., light fading	12 57 20		,,	Pretty good.
		½ light	13 1 20		,,	
		last seen	13 7 56·9	+3 44·9	,,	
	III.	Ec. Reapp., first seen	14 53 39·7	−3 23·2	,,	
		½ light	14 58 35		,,	
		full light	15 2 52		,,	

	Sat.	Phenomena.	G. M. T. h m s	Corr. to N. A. m	Observer.	Remarks.
March 13	I.	Ec. Disapp., fading	11 12 46·5		W. J. C.	
			11 17 15·5		,,	Definition poor.
			11 24 38·0	−0 23	,,	
May 7	I.	Ec. Reapp., first seen	10 13 7	−0 7	W. C.	
		½ light	10 14 10		,,	Definition good.
		full light	10 16 0		,,	
	I.	Ec. Reapp., first seen	10 13 24	+ 10	W. J. C.	
1888, Feb. 15	II.	Tr. Egress, last cont.	18 11 8·7		,,	Definition poor.
17	III.	Ec. Disapp., last seen	15 54 58	+1 56	W. C.	
		Ec. Reapp., first seen	17 23 32·0	−1 29	,,	Unsteady.
		full light	17 29 40		,,	
	III.	Ec. Reapp., first seen	17 23 35	−1 27	W. J. C.	
		½ light	17 26 6·5		,,	Dancing.
		full light	17 28 43		,,	
May 16	I.	Ec. Disapp., last seen	12 52 59	−0 9	W. C.	Good.
21	II.	Tr. Ingress, ext. cont.	11 57 30		,,	
		bisection	11 59 20		,,	Definition very bad.
		int. cont.	12 1 42		,,	
	II.	Tr. Egress, bisection	14 24 18		,,	Definition poor. Unsteady.
		last cont.	14 26 50		,,	

	Sat.	Phenomena.	G. M. T. h m s	Corr. to N. A.	Observer.	Remarks.
May 24	III.	Tr. Egress, bisection	10 27 12		W. C.	
		last cont.	10 32 1		,,	
	I.	Tr. Ingress, ext. cont.	11 44 49		,,	
		bisection	11 48 41		,,	
		int. cont.	11 51 40		,,	
	I.	Tr. Ingress, bisection	11 48 40		W. J. C.	Very poor. Dancing.
25	I.	Ec. Reapp., first seen	11 23 33·5	m s −0 3·5	W. C.	
		½ light	11 25 32		,,	
		full light	11 27 44		,,	
25	I.	Ec. Reapp., first seen	11 23 49·0	+0 12	W. J. C.	
June 17	I.	Ec. Reapp., first seen	11 34 47	−0 14	W. C.	
		½ light	11 36 8		,,	
		full light	11 37 20		,,	

The duplicate observations on May 7, 1887, and on February 17, May 24 and 25, 1888, were made by Mr. Crofton with the Alvan Clark 5½-inch refractor.

Observers: S. J. P., W. J. C., and W. C. are MM. Perry, Crofton, and Carlisle.

Observations of Occultations of Stars by the Moon, taken at Stonyhurst. By the Rev. S. J. Perry, D.Sc., F.R.S.

1886.	Phen.	Star.	G.M.T. h m s	Limb.	Observer.	Remarks.
Nov. 7	Disapp.	5 Ceti	6 0 40·1	Dark	W. C.	
1887.						
Feb. 6	Disapp.	3 Cancri	9 28 27·76	Dark	W. J. C.	Good
Mar. 8	,,	ρ Leonis	8 50 32·5	,,	J. R.	Excellent.
,, 29	,,	θ^1 Tauri	9 12 1·2	,,	W. C.	
,, 29	,,	θ^2 Tauri	9 19 8·8	,,	,,	
Apr. 2	,,	B.A.C. 2731	8 56 4·3	,,	,,	
,, 25	,,	48 Tauri	8 55 3·7	,,	W. J. C.	
,, 25	,,	,,	8 55 4·1	,,	W. C.	
Oct. 10	,,	ζ^1 Cancri	15 40 52·2	Bright	W. J. C.	
,, 10	,,	,,	15 40 52·2	,,	W. C.	Poor: Limb tremulous.
,, 10	Reapp.	,,	16 22 44·5	Dark	,,	Good.
,, 10	,,	ζ^2 Cancri	16 22 50·7	,,	,,	Fair.
Nov. 6	Disapp.	*g* Geminorum	10 30 18·4	Bright	,,	
,, 6	Reapp.	,,	11 5 24·5	Dark	,,	
,, 20	Disapp.	B.A.C. 7209	5 35 16·7	,,	,,	
Dec. 27	,,	75 Tauri	6 28 22·3	,,	W. J. C.	
1888.						
Mar. 20	Disapp.	68 Orionis	10 15 47·1	,,	W. C.	Pretty good.
,, 20	,,	,,	10 15 47·9	,,	W. J. C.	
,, 20	Reapp.	,,	11 20 48·9	Bright	W. C.	Fair.
May 20	Disapp.	*b* Virginis	12 55 30·5	Dark	,,	Very good.
,, 24	,,	η Libræ	10 50 49·6	Bright	,,	* very faint, difficult.
Sept. 14	,,	50 Sagittarii	10 52 3·9	Dark	W. J. C.	Thin clouds passing.
Oct. 13	,,	20 Capricorni	7 4 35·7		W. J. C.	
,, 13	,,	,,	7 4 36·5		W. C.	

A dark screen was inserted in the eyepiece whenever the star was observed near the bright limb of the Moon. The observations of the Rev. W. J. Crofton were made with the $5\frac{1}{2}$-inch refractor of Alvan Clark, and Mr. W. Carlisle always observed with the Simms 8-inch equatorial.

Note on the Occultation of χ' Orionis, 1888, October 24.
By Rev. A. Freeman, M.A.

This was very well seen here. Star disappeared at $9^h\ 2^m\ 8^s{\cdot}02$ in a hollow of the Moon's bright limb, and reappeared almost instantly from behind the dark limb at $9^h\ 55^m\ 26^s{\cdot}56$. Both times G.M.T. The chronometer had been

compared by means of a deck-watch with the noon signal at the R.A.S. rooms. Approximate position of the Observatory, 51° 20′ 3″·1 N. and 2^{m} 59^{s}·67 E. Aperture of O.G. 3½ in.

Murston Rectory, Sittingbourne:
1888, *October* 25.

Results of Micrometer Comparisons of Jupiter and β′ Scorpii in May 1888. By John Tebbutt.

This communication contains the results of filar-micrometer comparisons with the 8-inch equatorial of *Jupiter* and the well-known clock-star *β′ Scorpii* about the time of their conjunction in May last. In determining the difference of right ascension both limbs were observed at each transit over the single meridian thread of the micrometer. The correction for phase is insensible. In the determination of differences of declination the comparisons on each evening were equally divided between the north and south limbs. The differentials are corrected for refraction, and the resulting places of the planet for parallax. The steadiness and definition of the images were throughout satisfactory. In the last column will be found a comparison of the several stars with the theoretical places of the *Nautical Almanac*, from p. 352 of which work the place of the comparison star has been taken.

Results of Micrometer Comparisons of Jupiter and β′ Scorpii.

1888.	Windsor Mean Time.	Planet's Centre—Star. Δα	Δδ	Comps.	Planet's Geocentric Apparent α	δ	Obs.—N.A. α	δ
	h m s	m s	′ ″	h	m s	° ′ ″	s	″
May 14	9 47 41	+3 28·99	−11 10·6	10 16	2 26·04	−19 41 4·1	+0·11	+0·9
,, 15	9 25 57	+2 58·23	− 9 47·3	20 16	1 55·29	−19 39 40·9	+0·17	+1·4
,, 16	9 15 9	+2 26·98	− 8 24·0	20 16	1 24·05	−19 38 17·7	+0·11	+0·8
,, 17	9 35 36	+1 54·89	− 6 57·6	20 16	0 51·98	−19 36 51·2	+0·03	+1·1
,, 18	10 0 53	+1 22·64	− 5 31·0	20 16	0 19·76	−19 35 24·6	+0·02	+1·0
,, 19	9 30 23	+0 51·59	− 4 6·8	20 15	59 48·71	−19 34 0·5	+0·02	+1·2
,, 20	10 41 49	+0 18·18	− 2 36·3	20 15	59 15·35	−19 32 29·9	+0·02	+1·5
,, 21	10 22 35	−0 13·25	− 1 11·6	20 15	58 43·92	−19 31 5·2	−0·02	+1·2
,, 22	9 25 19	−0 43·86	+ 0 11·2	20 15	58 13·30	−19 29 42·5	−0·09	+1·0
,, 23	9 32 29	−1 15·86	+ 1 38·1	20 15	57 41·31	−19 28 15·6	−0·11	+1·0
,, 24	9 46 35	−1 48·01	+ 3 5·7	20 15	57 9·18	−19 26 48·0	−0·14	+1·2
,, 25	10 14 3	−2 20·39	+ 4 34·2	20 15	56 36·82	−19 25 19·5	−0·15	+1·6

Errata in my former Communications in the "Monthly Notices."

January 1888, p. 135, line 33 from top, *for* in ess *read* egress.

April 1888, p. 314, line 14 from top, *insert* equation *between* the *and* Lenehan-White.

May 1888, p. 340, line 4 from top, *for* evening *read* morning.

Windsor, N.S. Wales: 1888, *August* 20.

Ephemeris for Physical Observations of the Moon. By A. Marth.

1889, January 1 to April 1.

Greenwich Noon.	Selenographical Colong. of the Sun.	Selenographical Lat. of the Sun.	Geocentric Libration. Long. of the Earth.	Geocentric Libration. Lat. of the Earth.	Geocentric Libration. Amount.	Geocentric Libration. Direction.
1889.						
Jan. 1	262°·68	+0°·28	+2·06	−1°·80	2°·73	228°·7
2	274·87	0·26	3·72	−0·05	3·77	269·2
3	287·06	0·23	5·11	+1·68	5·38	288·2
4	299·25	0·20	6·14	3·26	6·95	298·0
5	311·43	0·18	6·76	4·60	8·17	304·3
6	323·61	+0·15	+6·96	+5·64	8·95	309·2
7	335·78	0·13	6·76	6·36	9·28	313·5
8	347·94	0·10	6·21	6·75	9·16	317·6
9	0·10	0·07	5·34	6·82	8·65	322·1
10	12·25	0·04	4·27	6·58	7·84	327·2
11	24·40	+0·01	3·02	6·06	6·62	333·6
12	36·54	−0·02	1·69	5·29	5·55	342·3
13	48·68	−0·05	+0·34	+4·29	4·30	355·4
14	60·82	0·08	−0·97	3·10	3·25	17·4
15	72·95	0·12	2·20	1·77	2·82	51·2
16	85·08	0·15	3·29	+0·34	3·31	84·1
17	97·21	0·18	4·22	−1·12	4·37	104·9
18	109·34	0·21	4·95	2·56	5·56	117·2
19	121·47	0·24	5·46	3·88	6·70	125·5
20	133·60	−0·28	−5·74	−5·04	7·63	131·4
21	145·74	0·31	5·78	5·95	8·29	136·0
22	157·88	0·34	5·58	6·55	8·59	139·8
23	170·03	0·37	5·12	6·81	8·52	143·2
24	182·19	0·39	4·42	6·67	8·00	146·6
25	194·35	0·42	3·50	6·14	7·07	150·4
26	206·52	0·44	2·39	5·23	5·75	155·5
27	218·70	−0·47	−1·13	−3·97	4·13	164·1
28	230·78	0·49	+0·23	2·48	2·49	185·3
29	243·07	0·52	1·61	−0·77	1·78	244·4
30	255·26	0·54	2·91	+0·96	3·07	288·2
31	267·46	0·56	4·06	2·59	4·82	302·6
Feb. 1	279·66	0·58	4·97	4·05	6·41	309·2
2	291·85	0·61	5·58	5 23	7·63	313·2
3	304·04	−0·63	+5·83	+6·09	8·42	316·4

Greenwich Noon.	Selenographical Colong. of the Sun.	Lat.	Geocentric Libration. Long. of the Earth.	Lat.	Amount.	Direction.
1889.						
Feb. 4	316°·22	−0°·65	+5°·71	+6°·60	8°·72	319°·3
5	328·40	0·68	5·23	6·77	8·55	322·5
6	340·58	0·70	4·43	6·62	7·97	326·3
7	352·75	0·73	3·38	6·18	7·04	331·4
8	4·92	0·76	2.15	5·47	5·88	338·6
9	17·08	0·78	+0·81	4·54	4·61	349·9
10	29·23	−0·81	−0·55	+3·41	3·45	9·1
11	41·38	0·84	1·85	2·13	2·82	40·9
12	53·52	0·86	3·01	+0·74	3·10	76·2
13	65·66	0·89	3·97	−0·71	4·03	100·1
14	77·80	0·92	4·68	2·14	5·15	114·6
15	89·94	0·94	5·11	3·50	6·19	124·5
16	102·07	0·97	5·24	4·71	7·04	132·0
17	114·21	−0·99	−5·09	−5·68	7·62	138·3
18	126·35	1·02	4·69	6·36	7·89	143·7
19	138·50	1·04	4·08	6·67	7·82	148·7
20	150·65	1·06	3·32	6·61	7·39	153·4
21	162·81	1·08	2·45	6·15	6·62	158·3
22	174·97	1·10	1·53	5·31	5·53	164·0
23	187·14	1·12	−0·57	4·16	4·20	172·1
24	199·32	−1·13	+0·38	−2·74	2·77	188·0
25	211·50	1·15	1·33	−1·16	1·76	228·8
26	223·69	1·17	2·23	+0·48	2·28	282·2
27	235·89	1·18	3·07	2·09	3·71	304·3
28	248·09	1·19	3·80	3·56	5·20	313·1
Mar. 1	260·29	1·21	4·37	4·79	6·48	317·7
2	272·50	1·22	4·73	5·73	7·43	320·6
3	284·71	−1·24	+4·82	+6·35	7·96	322·9
4	296·91	1·25	4·62	6·62	8·06	325·2
5	309·11	1·27	3·91	6·55	7·63	329·3
6	321·31	1·28	3·31	6·18	7·01	331·9
7	333·50	1·30	2·26	5·53	5·98	337·9
8	345·69	1·32	+1·02	4·66	4·77	347·7
9	357·87	1·33	−0·33	3·58	3·60	5·2
10	10·05	−1·35	−1·70	+2·36	2·91	35·8
11	22·22	1·36	3·01	+1·02	3·18	71·2
12	34·38	1·38	4·15	−0·37	4·16	95·1
13	46·54	1·39	5·04	1·78	5·34	109·5

Greenwich Noon.	Selenographica Colong. of the Sun.	Lat	Geocentric Libration. Long. of the Earth.	Lat.	Amount.	Direction.
1889.	°	°	°	°	°	°
Mar. 14	58·70	−1·41	−5·61	−3·13	6·42	119·2
15	70·86	1·42	5·81	4·36	7·26	127 0
16	83·01	1·44	5·63	5·38	7·78	133·8
17	95·16	−1·45	−5·08	−6·12	7·95	140·5
18	107·31	1·46	4·22	6·52	7·76	147·2
19	119·46	1·47	3·14	6·52	7·23	154·4
20	131·62	1·48	1·93	6·11	6·41	162·5
21	143·78	1·48	−0·71	5·32	5·36	172·4
22	155·95	1·49	+0·46	4·19	4·21	186·3
23	168·12	1·49	1·47	2·81	3·17	207·7
24	180·30	−1·50	+2·36	−1·27	2·68	241·8
25	192·49	1·50	3·10	+0·33	3·12	276·1
26	204·69	1·50	3·69	1·90	4·15	297·2
27	216·90	1·51	4·15	3·33	5·32	308·8
28	229·11	1·51	4·46	4·56	6·38	315·7
29	241·32	1·51	4·63	5·53	7·21	320·2
30	253·54	1·51	4·62	6·18	7·71	323·3
31	265·76	−1·51	+4·42	+6·50	7·85	326·0
April 1	277·98	1·52	3·98	6·49	7·61	328·6

The ephemeris is a continuation of that on p. 291 of the last volume.

Ephemerides of the Satellites of Saturn, 1888–89. By A. Marth. (Concluded.)

Approximate Differences of Right Ascension and Declination between the three Outer Satellites and the Centre of Saturn.

Greenwich Noon.	*Titan.*		*Hyperion.*		*Iapetus.*	
	$\alpha_6 - A$	$\delta_6 - D$	$\alpha_7 - A$	$\delta_7 - D$	$\alpha_8 - A$	$\delta_8 - D$
1889.	s	"	s	"	s	"
Jan. 1	− 0·61	+46·7	+13·53	+43·2	+36·51	− 8·6
2	− 6·01	+34·2	+10·17	+53·7	37·95	7·2
3	−10·48	+16·2	+ 5·52	+57·4	+39·17	− 5·7
4	−13·35	− 4·4	+ 0·16	+54·1	40·16	4·1
5	−14·25	−24·5	− 5·24	+44·4	+40·91	− 2·5
6	−13·08	−41·2	−10·10	+30·0	41·41	− 0·8

Greenwich Noon. 1889.		*Titan.* α_6-A	*Titan.* δ_6-D	*Hyperion.* α_7-A	*Hyperion.* δ_7-D	*Iapetus.* α_8-A	*Iapetus.* δ_8-D
		s	″	s	″	s	″
Jan.	7	−10·04	−52·1	−14·00	+12·5	+41·65	+ 1·0
	8	− 5·57	−55·6	−16·71	− 6·2	41·64	2·8
	9	− 0·30	−51·3	−18·10	−24·5	+41·37	+ 4·6
	10	+ 5·02	−39·5	−18·19	−41·2	40·84	6·4
	11	+ 9·61	−21·7	−17·05	−55·2	+40·06	+ 8·2
	12	+12·71	− 0·6	−14·81	−65·7	39·02	10·0
	13	+13·79	+20·8	−11·63	−72·2	+37·73	+11·8
	14	+12·60	+38·9	− 7·71	−74·2	36·19	13·5
	15	+ 9·30	+50·5	− 3·31	−71·5	+34·42	+15·2
	16	+ 4·44	+53·8	+ 1·34	−64·0	32·42	16·8
	17	− 1·18	+48·1	+ 5·91	−52·0	+30·20	+18·3
	18	− 6·62	+34·5	+ 9·99	−36·0	27·78	19·7
	19	−11·03	+15·3	+13·24	−16·8	+25·17	+21·0
	20	−13·75	− 6·3	+15·26	+ 3·9	22·39	22·2
	21	−14·43	−27·1	+15·69	+24·4	+19·45	+23·2
	22	−13·03	−44·1	+14·32	+42·1	16·38	24·0
	23	− 9·76	−54·8	+11·20	+54·7	+13·19	+24·7
	24	− 5·10	−58·0	+ 6·66	+60·5	9·91	25·2
	25	+ 0·29	−52·8	+ 1·27	+58·8	+ 6·55	+25·5
	26	+ 5·64	−40·0	− 4·28	+50·0	+ 3·15	25·6
	27	+10·15	−21·0	− 9·36	+35·7	− 0·28	+25·4
	28	+13·08	+ 1·2	−13·56	+17·8	3·72	25·1
	29	+13·93	+23·3	−16·55	− 1·8	− 7·13	+24·6
	30	+12·48	+41·7	−18·21	−21·4	10·49	23·8
	31	+ 8·94	+53·2	−18·53	−39·5	−13·78	+22·8
Feb.	1	+ 3·89	+55·8	−17·57	−55·0	16·97	21·6
	2	− 1·81	+49·1	−15·47	−67·0	−20·05	+20·3
	3	− 7·22	+34·4	−12·40	−74·8	22·98	18·7
	4	−11·50	+14·2	− 8·54	−78·1	−25·75	+16·9
	5	−14·02	− 8·3	− 4·16	−76·3	28·34	15·0
	6	−14·46	−29·7	+ 0·53	−69·6	−30·74	+12·9
	7	−12·81	−46·8	+ 5·16	−58·0	32·91	10·6
	8	− 9·33	−57·4	+ 9·40	−42·0	−34·85	+ 8·2
	9	− 4·53	−59·9	+12·83	−22·5	36·55	5·7
	10	+ 0·92	−53·8	+15·16	− 1·0	−37·99	+ 3·1
	11	+ 6·23	−39·9	+15·86	+20·7	39·16	+ 0·4
	12	+10·60	−19·9	+14·82	+40·1	−40·05	− 2·3

Greenwich Noon. 1889.		*Titan.*		*Hyperion.*		*Iapetus.*	
		$\alpha_6 - A$	$\delta_6 - D$	$\alpha_7 - A$	$\delta_7 - D$	$\alpha_8 - A$	$\delta_8 - D$
		s	″	s	″	s	″
Feb.	13	+13·32	+ 3·1	+11·98	+54·7	−40·67	− 5·1
	14	+13·90	+25·8	+ 7·63	+62·5	−41·01	− 7·9
	15	+12·20	+44·2	+ 2·33	+62·4	41·06	10·6
	16	+ 8·45	+55·3	− 3·27	+54·8	−40·83	−13·4
	17	+ 3·29	+57·1	− 8·50	+41·1	40·33	16·1
	18	− 2·42	+49·6	−12·88	+23·1	−39·55	−18·7
	19	− 7·74	+33·8	−16·09	+ 2·9	38·50	21·2
	20	−11·84	+12·7	−17·97	−17·6	−37·20	−23·6
	21	−14·13	−10·4	−18·51	−36·8	35·66	25·8
	22	−14·32	−32·1	−17·76	−53·5	−33·88	−27·9
	23	−12·45	−49·1	−15·84	−66·8	31·88	29·9
	24	− 8·81	−59·3	−12·92	−75·9	−29·68	−31·6
	25	− 3·92	−61·0	− 9·20	−80·2	27·29	33·1
	26	+ 1·52	− 54·0	− 4·90	−79·6	−24·73	−34·5
	27	+ 6·72	−39·2	− 0·29	−73·7	22·01	35·6
	28	+10·91	−18·5	+ 4·33	−62·8	−19·16	−36·5
Mar.	1	+13·39	+ 5·1	+ 8·62	−47·3	16·19	37·1
	2	+13·73	+27·9	+12·20	−28·0	−13·13	−37·5
	3	+11·81	+46·1	+14·69	− 6·2	9·99	37·6
	4	+ 7·90	+56·6	+15·71	+16·2	− 6·80	−37·5
	5	+ 2·68	+57·7	+15·00	+36·8	3·57	37·1
	6	− 2·97	+49·1	+12·52	+53·0	− 0·32	−36·5
	7	− 8·14	+32·6	+ 8·48	+62·6	+ 2·92	35·6
	8	−12·02	+10·9	+ 3·37	+64·3	+ 6·13	−34·5
	9	−14·06	−12·4	− 2·14	+58·1	9·30	33·2
	10	−14·03	−34·0	− 7·41	+45·4	+12·41	−31·6
	11	−11·97	−50·7	−11·90	+27·9	15·43	29·8
	12	− 8·24	−60·2	−15·29	+ 7·8	+18·36	−27·8
	13	− 3·33	−61·2	−17·39	−13·0	21·17	25·6
	14	+ 2·03	−53·4	−18·16	−32·8	+23·85	−23·2
	15	+ 7·08	−37·9	−17·66	−50·3	26·38	20·6
	16	+11·06	−16·8	−15·98	−64·5	+28·74	−17·9
	17	+13·30	+ 7·0	−13·29	−74·6	30·93	15·1
	18	+13·41	+29·6	− 9·79	−80·1	+32·93	−12·2
	19	+11·32	+47·2	− 5·67	−80·5	34·73	9·2
	20	+ 7·34	+57·0	− 1·21	−75·8	36·32	− 6·1
	21	+ 2·14	+57·3	+ 3·32	−66·0	37·69	− 3·0
	22	− 3·40	+48·0	+ 7·59	−51·4	+38·82	+ 0·2

Greenwich Noon. 1889.		*Titan.* α_6-A	δ_6-D	*Hyperion.* α_7-A	δ_7-D	*Iapetus.* α_8-A	δ_8-D
		s	″	s	″	s	″
Mar.	23	− 8·38	+31·0	+11·25	−32·9	+38·72	+ 3·4
	24	−12·03	+ 9·2	+13·92	−11·6	+40·39	+ 6·6
	25	−13·86	−14·0	+15·24	+10·8	40·81	9·7
	26	−13·64	−35·2	+14·93	+31·9	+40·99	+12·8
	27	−11·47	−51·3	+12·88	+49·3	40·92	15·8
	28	− 7·69	−60·1	+ 9·24	+60·5	+40·60	+18·8
	29	− 2·83	−60·4	+ 4·46	+64·2	40·03	21·6
	30	+ 2·42	−52·1	− 0·87	+59·8	+39·22	+24·2
	31	+ 7·29	−36·2	− 6·08	+48·6	38·17	26·7
April	1	+11·06	−15·0	−10·65	+32·3	+36·89	+29·1
	2	+13·09	+ 8·5	−14·19	+12·9	35·39	31·2
	3	+13·02	+30·5	−16·52	− 7·6	+33·67	+33·2
	4	+10·82	+47·5	−17·56	−27·4	31·74	34·9
	5	+ 6·82	+56·5	−17·34	−45·3	+29·62	+36·4
	6	+ 1·70	+56·0	−15·98	−60·1	27·32	37·6
	7	− 3·69	+46·3	−13·60	−71·0	+24·86	+38·6
	8	− 8·47	+29·2	−10·38	−77·5	22·25	39·4
	9	−11·91	+ 7·6	− 6·53	−79·1	+19·50	+39·9
	10	−13·55	−15·2	− 2·31	−75·8	16·63	40·1
	11	−13·20	−35·6	+ 2·10	−67·4	+13·67	+40·0
	12	−10·97	−50·9	+ 6·32	−54·3	10·63	39·6
	13	− 7·20	−59·0	+10·03	−37·2	+ 7·53	+39·0
	14	− 2·43	−58·7	+12·88	−16·9	4·39	38·2
	15	+ 2·67	−50·1	+14·51	+ 4·7	+ 1·24	+37·1
	16	+ 7·36	−34·3	+14·63	+25·8	− 1·91	35·7
	17	+10·92	−13·3	+13·08	+43·8	− 5·03	+34·1
	18	+12·78	+ 9·5	+ 9·95	+56·4	8·11	32·2
	19	+12·59	+30·8	+ 5·58	+61·9	−11·12	+30·2
	20	+10·34	+46·9	+ 0·53	+59·7	14·04	27·9
	21	+ 6·38	+55·1	− 4·56	+50·5	−16·86	+25·5
	22	+ 1·37	+54·1	− 9·16	+35·9	19·55	22·9
	23	− 3·85	+44·3	−12·85	+17·8	−22·10	+20·2
	24	− 8·43	+27·3	−15·42	− 1·7	24·49	17·4
	25	−11·70	+ 6·2	−16·77	−21·0	−26·70	+14·5
	26	−13·19	−15·8	−16·90	−38·8	28·72	11·5
	27	−12·76	−35·4	−15·89	−53·9	−30·54	+ 8·4
	28	−10·52	−49·8	−13·88	−65·4	32·15	5·3
	29	− 6·80	−57·2	−11·01	−72·8	−33·53	+ 2·2

Greenwich Noon 1889.	*Titan.* α_6-A	δ_6-D	*Hyperion.* α_7-A	δ_7-D	*Iapetus.* α_8-A	δ_8-D
	s	″	s	″	s	″
April 30	− 2·15	−56·5	− 7·44	−75·8	−34·68	− 0·9
May 1	+ 2·79	−47·8	− 3·47	−73·9	−35·60	− 3·9
2	+ 7·31	−32·2	+ 0·72	−67·2	36·28	6·9
3	+10·71	−11·9	+ 4·85	−55·9	−36·71	− 9·8
4	+12·44	+10·2	+ 8·60	−40·6	36·90	12·6
5	+12·18	+30·4	+11·63	−22·0	−36·85	−15·3
6	+ 9·92	+45·7	+13·59	− 1·5	36·56	17·9
7	+ 6·03	+53·2	+14·16	+19·0	−36·03	−20·3
8	+ 1·16	+51·8	+13·17	+37·2	35·28	22·5
9	− 3·89	+42·0	+10·59	+50·9	−34·31	−24·6
10	− 8·31	+25·5	+ 6·71	+58·1	33·12	26·5
11	−11·42	+ 5·1	+ 2·01	+58·1	−31·73	−28·2
12	−12·82	−15·9	− 2·92	+51·1	30·15	29·7
13	−12·35	−34·5	− 7·51	+38·7	−28·39	−31·0
14	−10·14	−48·2	−11·35	+22·4	26·47	32·1
15	− 6·51	−54·9	−14·17	+ 4·2	−24·39	−33·0
16	− 1·98	−54·0	−15·85	−14·2	22·17	33·6
17	+ 2·81	−45·3	−16·36	−31·5	−19·82	−34·1
18	+ 7·17	−30·2			17·37	34·4
19	+10·44	−10·6			−14·83	−34·4
20	+12·08	+10·4			12·21	34·2
21	+11·79	+29·7			− 9·52	−33·9
22	+ 9·58	+44·0			6·79	33·4
23	+ 5·78	+50·9			− 4·03	−32·6
24	+ 1·04	+49·3			− 1·27	31·7
25	− 3·85	+39·7			+ 1·49	−30·7
26	− 8·12	+23·8			4·23	29·5
27	−11·12	+ 4·3			+ 6·94	−28·2

Approximate Greenwich Mean Times of Conjunctions of the Satellites with the Centre of the Planet, or of their Passages in the direction of the Minor Axis of the Ring.

1889.	h			h			h	
Jan. 1	10·9	En. n.	Jan. 3	9·5	Te. n.	Jan. 5	6·8	Te. n.
	12·2	Rh. s.		12·2	En. s.		13·5	En. n.
	12·2	Te. n.		12·2	Mi. s.		17·4	Di. n.
	14·9	Di. s.		18·3	Rh. n.		20·8	Mi. n.
	15·0	Mi. s.	4	8·2	Te. s.	6	0·5	Rh. s.
2	10·9	Te. s.		8·5	Di. s.		5·5	Te. s.
	13·6	Mi. s.		10·8	Mi. s.		6·0	En. s.
	19·8	En. n.		21·1	En. s.		19·4	Mi. n.
	23·7	Di. n.		22·1	Mi. n.		22·4	En. n.

1889.	h		h		h
Jan. 7	2·2 Di. s.		7·8 Te. s.		2·5 Rh. s.
	4·1 Te. n.		19·7 Rh. n.		14·2 Te. n.
	14·9 En. s.		21·2 Mi. n.		15·5 En. s.
	18·0 Mi. n.	Jan. 22	3·3 Di. n.		15·9 Mi. s
8	2·8 Te. s.		6·4 Te. n.	Feb. 3	7·9 En. n.
	6·7 Rh. n.		16·5 En. s.		10·7 Di. s.
	7·3 En. n.		19·8 Mi. n.		12·8 Te. s.
	11·0 Di. n.	23	5·1 Te. s.		14·5 Mi. s.
	16·6 Mi. n.		8·9 En. n.	4	8·6 Rh. n.
	23·7 En. s.		12·1 Di. s.		11·5 Te. n.
9	1·4 Te. n.		18·4 Mi. n.		13·1 Mi. s.
	3·4 Tit. s. 50″	24	1·8 Rh. s.		16·8 En. n.
	15·2 Mi. n.		3·7 Te. n.		19·5 Di. n.
	16·2 En. s.		17·0 Mi. n.	5	9·2 En. s.
	17·8 Di. s.		17·8 En. n.		10·1 Te. s.
10	0·0 Te. s.		20·9 Di. n.		11·7 Mi. s.
	8·6 En. s.	25	0·7 Tit. s. 53″	6	4·3 Di. s.
	12·8 Rh. s.		2·4 Te. s.		8·7 Te. n.
	13·8 Mi. n.		10·2 En. s.		10·3 Mi. s.
	22·7 Te. n.		15·6 Mi. n.		14·8 Rh. s.
11	2·7 Di. n.		20·4 Rh. & Iap.		18·1 En. s.
	12·4 Mi. n.	26	1·0 Te. n.	7	7·4 Te. s.
	17·5 En. s.		5·7 Di. s.		8·9 Mi. s.
	21·3 Te. s.		8·0 Rh. n.		10·6 En. n.
12	9·9 En. n.		12·3 Iap. fn. 23″		13·2 Di. n.
	11·1 Mi. n.		14·3 Mi. n.		20·2 Mi. n.
	11·5 Di. s.		19·2 En. s.	8	6·0 Te. n.
	19·0 Rh. n.		23·5 Iap. n. 26″		18·8 Mi. n.
	20·0 Te. n.		23·7 Te. s.		19·4 En. n.
13	18·6 Te. s.	27	10·8 Iap. pn. 28″		20·9 Rh. n.
	18·8 En. n.		11·6 En. n.		22·0 Di. s.
	20·3 Di. n.		12·9 Mi. n.	9	4·7 Te. s.
	21·0 Mi. s.		14·6 Di. n.		11·9 En. s.
14	11·2 En. s.		22·3 Te. n.		17·5 Mi. n.
	17·3 Te. n.	28	11·5 Mi. n.		22·0 Tit. s. 55″
	19·6 Mi. s.		14·1 Rh. s.	10	3·3 Te. n.
15	1·2 Rh. s.		20·4 En. n.		6·8 Di. n.
	5·1 Di. s.		20·9 Te. s.		16·1 Mi. n.
	15·9 Te. s.		22·8 Mi. s.		20·7 En. s.
	18·2 Mi. s.		23·4 Di. s.	11	2·0 Te. s.
	20·1 En. s.	29	10·1 Mi. n.		3·1 Rh. s.
16	12·6 En. n.		12·9 En. s.		13·2 En. n.
	14·0 Di. n.		19·6 Te. n.		14·7 Mi. n.
	14·6 Te. n.		21·4 Mi. s.		15·6 Di. s.
	16·8 Mi. s.	30	8·2 Di. n.	12	0·6 Te. n.
	20·8 Tit. n. 50″		18·2 Te. s.		13·3 Mi. n.
17	7·3 Rh. n.		20·0 Mi. s.		22·1 En. n.
	13·2 Te. s.		20·3 Rh. n.		23·3 Te. s.
	22·8 Di. s.		21·7 En. s.	13	0·5 Di. n.
18	11·9 Te. n.	31	14·2 En. n.		9·3 Rh. n.
19	7·6 Di. n.		16·9 Te. n.		21·9 Te. n.
	10·5 Te. s.		17·0 Di. s.	14	9·3 Di. s.
	13·5 Rh. s.		18·6 Mi. s.		20·5 Te. s.
	22·7 En. s.	Feb. 1	6·6 En. s.	15	15·4 Rh. s.
20	9·1 Te. n.		15·5 Te. s.		15·8 En. n.
	15·2 En. n.		17·2 Mi. s.		18·1 Di. n.
	16·4 Di. s.		18·3 Tit. n. 51″		19·2 Te. n.
	22·6 Mi. n.		23·1 En. n.	16	8·3 En. s.
21	7·6 En. s.	2	1·9 Di. n.		17·8 Te. s.

1889.	h			h			h
	19·1 Mi. s.			12·4 Mi. n.			8·9 En. s.
Feb. 17	2·9 Di. s.			22·9 Te. s.			17·4 Rh. s.
	15·8 Tit. n. 53″		Mar. 2	11·0 Mi. n.		Mar. 15	2·7 Di. n.
	16·5 Te. n.			17·5 En. n.			4·0 Te. s.
	17·1 En. s.			19·2 Di. s.		16	2·6 Te. n.
	17·7 Mi. s.			21·5 Te. n.			10·3 En. n.
	21·6 Rh. n.		3	9·6 Mi. n.			11·5 Di. s.
18	9·6 En. n.			9·9 En. s.			23·6 Rh. n.
	11·8 Di. n.			10·6 Rh. n.		17	1·3 Te. s.
	15·1 Te. s.			20·2 Te. s.			12·8 Mi. n.
	16·3 Mi. s.		4	4·0 Di. n.			19·2 En. n.
19	13·8 Te. n.			8·2 Mi. n.			20·3 Di. n.
	14·9 Mi. s.			18·8 En. s.			23·9 Te. n.
	18·4 En. n.			18·8 Te. n.		18	11·5 Mi. n.
	20·6 Di. s.		5	11·2 En. n.			11·6 En. s.
20	3·7 Rh. s.			12·9 Di. s.			22·6 Te. s.
	10·9 En. s.			13·4 Tit. n. 54″		19	5·2 Di. s.
	12·4 Te. s.			16·7 Rh. s.			5·8 Rh. s.
	13·5 Mi. s.			17·0 Iap. ps. 34″			10·1 Mi. n.
21	5·4 Di. n.			17·5 Te. s.			20·5 En. s.
	11·1 Te. n.			18·1 Mi. s.			21·2 Te. n.
	12·1 Mi. s.		6	4·8 Iap. s. 37″		20	8·7 Mi. n.
	19·8 En. s.			16·1 Te. n.			12·9 En. n.
22	9·7 Te. s.			16·5 Iap. fs. 39″			14·0 Di. n.
	9·9 Rh. n.			16·8 Mi. s.			19·9 Te. s.
	10·8 Mi. s.			20·1 En. n.		21	5·4 En. s.
	12·2 En. n.			21·7 Di. n.			7·3 Mi. n.
	14·2 Di. s.		7	12·5 En. s.			11·3 Tit. n. 54″
23	8·4 Te. n.			14·8 Te. s.			12·0 Rh. n.
	9·4 Mi. s.			15·4 Mi. s.			18·5 Te. n.
	20·7 Mi. n.			22·9 Rh. n.			18·6 Mi. s.
	21·1 En. n.		8	6·5 Di. s.			21·8 En. n.
	23·1 Di. n.			13·4 Te. n.			22·8 Di. s.
24	7·0 Te. s.			14·0 Mi. s.		22	14·2 En. s.
	13·5 En. s.			21·4 En. s.			17·2 Te. s.
	16·1 Rh. s.		9	12·1 Te. s.			17·2 Mi. s.
	19·3 Mi. n.			12·6 Mi. s.		23	6·7 En. n.
25	5·6 Te. n.			13·9 En. n.			7·7 Di. n.
	6·0 En. n.			15·3 Di. n.			15·8 Te. n.
	7·9 Di. s.		10	5·1 Rh. s.			15·9 Mi. s.
	17·9 Mi. n.			6·3 En. s.			18·2 Rh. s.
	19·5 Tit. s. 56″			✶ 9^{m} near.†		24	14·5 Te. s.
26	4·3 Te. s.			10·7 Te. n.			14·5 Mi. s.
	14·8 En. n.			11·2 Mi. s.			15·0 En. n.
	16·5 Mi. n.		11	0·2 Di. s.			16·5 Di. s.
	16·7 Di. n.			9·4 Te. s.		25	8·0 En. s.
	22·2 Rh. n.			9·8 Mi. s.			13·1 Mi. s.
27	2·9 Te. n.			15·2 En. s.			13·1 Te. n.
	7·3 En. s.		12	7·6 En. n.		26	0·4 Rh. n.
	15·1 Mi. n.			8·0 Te. n.			1·4 Di. n.
28	1·5 Di. s.			8·4 Mi. s.			11·7 Mi. s.
	1·6 Te. s.			9·0 Di. n.			11·8 Te. s.
	13·8 Mi. n.			11·3 Rh. n.			16·9 En. s.
	16·2 En. s.		13	6·7 Te. s.		27	9·3 En. n.
Mar. 1	0·2 Te. n.			16·5 En. n.			10·2 Di. s.
	4·4 Rh. s.			17·1 Tit. s. 57″			10·3 Mi. s.
	8·6 En. n.			17·8 Di. s.			10·4 Te. n.
	10·4 Di. n.		14	5·3 Te. n.		28	6·6 Rh. s.

† The star is D.M. + 17°·2043; *v.* note, May 18.

1889.	h	
	8·9	Mi. s.
	9·1	Te. s.
	18·2	En. n.
	19·0	Di. n.
Mar. 29	7·6	Mi. s.
	7·7	Te. n.
	10·7	En. s.
	15·2	Tit. s. 56″
30	3·9	Di. s.
	6·4	Te. s.
	12·8	Rh. n.
	17·5	Mi. n.
31	5·0	Te. n.
	12·0	En. n.
	12·7	Di. n.
	16·1	Mi. n.
Apr. 1	3·7	Te. s.
	14·7	Mi. n.
	19·0	Rh. s.
	21·6	Di. s.
2	2·3	Te. n.
	13·3	En. s.
	13·3	Mi. n.
3	1·0	Te. s.
	5·8	En. n.
	6·4	Di. n.
	12·0	Mi. n.
	23·6	Te. n.
4	1·2	Rh. n.
	10·6	Mi. n.
	14·6	En. n.
	15·2	Di. s.
	22·3	Te. s.
5	7·1	En. s.
	9·2	Mi. n.
	20·9	Te. n.
6	0·1	Di. n.
	7·4	Rh. s.
	7·8	Mi. n.
	9·6	Tit. n. 53″
	16·0	En. s.
	19·6	Te. s.
7	6·4	Mi. n.
	8·4	En. n.
	8·9	Di. s.
	18·2	Te. n.
8	13·6	Rh. n.
	16·4	Mi. s.
	16·9	Te. s.
	17·3	En. n.
	17·8	Di. n.
9	9·7	En. s.
	15·0	Mi. s.
	15·6	Te. n.
10	2·6	Di. s.
	14·2	Te. s.
	19·8	Rh. s.
11	11·1	En. n.
	11·4	Di. n.
	12·2	Mi. s.
	12·9	Te. n.
Apr. 12	10·8	Mi. s.
	11·5	Te. s.
	20·3	Di. s.
13	2·0	Rh. n.
	9·5	Mi. s.
	10·2	Te. n.
	12·4	En. s.
14	5·1	Di. n.
	8·1	Mi. s.
	8·8	Te. s.
	13·7	Tit. s. 55″
15	0·5	Iap. fn. 35″
	7·5	Te. n.
	8·2	Rh. s.
	11·9	Iap. n. 37″
	13·7	En. n.
	14·0	Di. s.
	23·3	Iap. pn. 39′,
16	6·1	Te. s.
	6·2	En. s.
	16·6	Mi. n.
	22·8	Di. n.
17	4·8	Te. n.
	14·4	Rh. n.
	15·1	En. s.
	15·3	Mi. n.
18	3·5	Te. s.
	7·5	En. n.
	7·7	Di. s.
	13·9	Mi. n.
19	2·1	Te. n.
	12·5	Mi. n.
	16·4	En. n.
	16·5	Di. n.
	20·7	Rh. s.
20	0·8	Te. s.
	8·9	En. s.
	11·1	Mi. n.
	23·4	Te. n.
21	1·4	Di. s.
	9·7	Mi. n.
	22·1	Te. s.
22	2·9	Rh. n.
	8·3	Tit. n. 52″
	8·4	Mi. n.
	10·2	En. n.
	10·2	Di. n.
	20·7	Te. n.
23	19·1	Di. s.
	19·4	Te. s.
24	9·1	Rh. s.
	11·5	En. s.
	16·9	Mi. s.
	18·1	Te. n.
25	3·9	Di. n.
	15·5	Mi. s.
	16·7	Te. s.
Apr. 26	12·8	Di. s.
	12·9	En. n.
	14·2	Mi. s.
	15·3	Rh. n.
	15·4	Te. n.
27	12·8	Mi. s.
	14·0	Te. s.
	21·6	Di. n.
28	11·4	Mi. n.
	12·7	Te. n.
	14·2	En. s.
	21·6	Rh. s.
29	6·5	Di. s.
	6·6	En. n.
	10·0	Mi. s.
	11·4	Te. s.
30	10·0	Te. n.
	12·7	Tit. s. 53″
	15 3	Di. n.
	15·5	En. n.
May 1	3·8	Rh. n.
	8·0	En. s.
	8·7	Te. s.
2	0·2	Di. s.
	7·3	Te. n.
	16·9	En. s.
3	6·0	Te. s.
	9·0	Di. n.
	9·3	En. n.
	10·0	Rh. s.
4	4·6	Te. n.
	14·4	Mi. n.
	18·0	Di. s.
5	3·3	Te. s.
	10·7	En. s.
	13·1	Mi. n.
	16·3	Rh. n.
6	2·0	Te. n.
	2·7	Di. n.
	11·7	Mi. n.
7	0·6	Te. s.
	11·6	Di. s.
	12 0	En. n.
	22·5	Rh. s.
	23·3	Te. n.
8	7·5	Tit. n. 50″
	20·5	Di. n.
	21·9	Te. s.
9	13·3	En. s.
	20·6	Te. n.
10	4·8	Rh. n.
	5·3	Di. s.
	19·3	Te. s.
11	14·2	Di. n.
	17·9	Te. n.
12	11·0	Rh. s.
	16·6	Te. s.
	23·0	Di. s.
13	15·3	Te. n.

1889.	h			h			h
May 14	7·9	Di. n.		✶9ᵐ near.†	May 24	21·9	Di. s.
	13·9	Te. s.	May 19	5·8 Rh. n.		0·5	Te. s.
	17·2	Rh. n.		7·2 Te. n.		1·3	Iap. ps. 29″
15	12·6	Te. n.		19·3 Di. n.		7·0	Tit. n. 47″
	16·8	Di. s.	20	5·9 Te. s.		13·4	Iap. s. 31″
16	11·2	Te. s.	21	4·2 Di. s.		23·2	Te. n.
	12·1	Tit. s. 51″		4·6 Te. n.	25	1·5	Iap. fs. 33″
	23·5	Rh. s.		12·0 Rh. s.		6·8	Di. n.
17	1·6	Di. n.	22	3·2 Te. s.		21·9	Te. s.
	9·9	Te. n.		13·0 Di. n.	26	0·5	Rh. s.
18	8·6	Te. s.	23	1·9 Te. n.			
	10·5	Di. s.		18·3 Rh. n.			

† The star is D.M. + 17°·2043, and is also found in the Markree Cat. IV. p. 121, but does not seem to have been observed with meridian instruments anywhere. As the D.M. place gives an occultation by *Saturn* on May 18, it would be desirable that the accurate position of the star should be determined by timely observations in the meridian, so that the circumstances of the occultation or close conjunction may be computed in good time before its occurrence. The D.M. magnitude of the star in 9ᵐ·1 and its place for 1889·0 α 9ʰ 9ᵐ 12ˢ δ + 17° 35′·6.